C.S.I.R.O.

Forest Products Newsletter

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COMMON BORERS IN BUILDING TIMBERS

Part III. The Anobiid Borers

By J. BEESLEY, Wood Preservation Section

ALTHOUGH not so common in Australia as the Lyctus borer, the Anobiids,* or "furniture borers" as they are sometimes misleadingly called, are perhaps the more serious pest of the two. Like Lyctus, they attack seasoned timber, making flight or exit holes similar in appearance to those made by Lyctus. Unlike Lyctus, which attacks only the sapwood of hardwoods, the Anobiids sometimes attack the heartwood as well as the sapwood, and typically attack softwoods, although some hardwoods are susceptible.

LIFE HISTORY OF THE ANOBIUM BORER

The life history of *Anobium punctatum*, which is typical for the group, is completed in four stages, namely: egg, larva (or grub), pupa, and mature beetle. The cycle from the laying of the egg to the emergence of the mature beetle varies between one and four or more years, but usually takes three or four years.

During spring and early summer in temperate regions, the female beetle lays her eggs on the surface of suitable timber, showing a distinct preference for rough sawn surfaces, especially end grain. The eggs are usually placed in cracks, crevices, and joints, or laid in old flight or exit holes, but rarely on smooth surfaces.

The larvae hatch out within four weeks, and start boring into the wood. They may then tunnel beneath the surface for several years, depending upon the climate and timber species. After pupating, the mature beetles emerge by cutting exit holes in the surface of the wood. These flight holes give little indication of the extensive network of galleries, loosely packed with frass, which the feeding larvae have excavated.

The adult Anobium beetle is small, about $\frac{3}{16}$ in. in length, and dull grey in colour. When viewed from above with a hand lens, the head, which is shielded by a hood-shaped segment, is almost invisible and the wing covers appear to be finely furrowed. The beetles, which are not strong fliers, mate soon after emergence, and the females then seek suitable places for egg-laying.

RECOGNITION OF ANOBIID ATTACK

Frass and Emergence Holes

A characteristic of Abobiid attack is the frass, which consists of small granules or pellets which feel hard and gritty when

* The common Anobiid borers in Australia are *Anobium punctatum* de Geer in the southern States, and *Calymmaderus incisus* Lea in Queensland, which attacks only hoop pine.

rubbed lightly between the fingers. When seen through a hand lens, the granules of *Calymmaderus* frass are egg-shaped. The emergence holes, which are not stained around their margins, are small ($\frac{1}{32}$–$\frac{1}{16}$ in. in dia.), round, and generally more abundant on the underside of a board than on the exposed face.

Timbers Subject to Attack

In Australia, the Anobiid borers are usually found attacking softwood timbers such as New Zealand white pine, Queensland hoop and kauri pines, and the so-called "Baltic" pines or "deals". Certain imported hardwood timbers, such as English oak (*Quercus* spp.), and a few Australian hardwoods such as red cedar, are also susceptible to attack. Attack in eucalypt hardwoods is extremely rare.

Both the sapwood and heartwood of susceptible timbers may be attacked. In softwoods, attack, which may cause extensive damage, usually begins in the sapwood, but may extend into the heartwood. In susceptible hardwoods attack may be initiated in the heartwood.

Under Australian conditions, attack is rarely observed in timber which has not been in service for at least 10 years.

Conditions Favouring Attack

The Anobiids generally prefer environments where temperatures are fairly uniform and relatively cool. Hence attack is more likely to occur at floor level, where these conditions prevail, than in roof timbers where extremes of temperature occur.

Calymmaderus attack usually commences in dark corners on the underside of a floor, and from there extends to unpainted hoop pine partitions and skirtings.

Persistence of Attack

Anobiid attack may continue in the same piece of wood for many years, as the beetles have a tendency to lay their eggs in their own or nearby flight holes. Thus, the attack of several successive generations of borer may be more concentrated at one end of an infested board than at the other. Unless checked Anobiid attack may proceed until the infested wood has been seriously weakened, if not destroyed.

TREATMENT OF ANOBIID ATTACK

Complete eradication of Anobiid attack is seldom accomplished without repeated treatments, which should be commenced as soon as attack is discovered and repeated annually for the next three or four years.

In the southern parts of Australia these "follow-up" treatments should be made at both the beginning and end of the borer flight season, which usually extends from mid November to mid January. Elsewhere, the "follow-up" treatments should be made as soon as any signs of activity are noticed, and then repeated 8 or 10 weeks later.

Method of Treatment

(*a*) *Bare Woodwork* (Flooring, Partitions, etc.): (i) Initial Treatment.—Thoroughly saturate infested wood by injection (with a syringe or small oil can) or by floodspraying (on the underside of floors) with a suitable preservative containing a persistent contact insecticide. Wherever possible assist penetration by removing loose dust from borer holes with a vacuum cleaner. Make sure that all exposed surfaces have been well wetted with preservative.

(ii) "Follow-up" Treatments.—Each year, for the three or four years following the initial treatment, apply a liberal flood coating of the same preservative to all exposed surfaces of the infested wood.

(*b*) *Polished or Painted Woodwork*: (i) Initial Treatment.—Remove loose dust from borer flight holes with a vacuum cleaner. To obtain maximum penetration, use a syringe or small oil can to force the preservative into the exit holes, making sure that all holes are treated. If the holes are very numerous, or the article can be laid flat, brush several flowing coats of preservative over the surface.

After the preservative has had time to dry, fill the flight holes and restore the surface finish.

(ii) "Follow-up" Treatments.—Repeat the injection treatment whenever fresh holes appear and, at the same time, spray or otherwise coat surfaces which do not have a high polish with a persistent contact insecticide.

Insecticides to Use

Only contact insecticides with a residual action, which may be dissolved in a light, mineral oil solvent (kerosene, mineral turpentine, etc.), should be used to treat Anobiid attack. The following table indicates effective concentrations of suitable insecticides:

Insecticide	Concentration	
	Percentage	Oz/Gal (approx.)
Dieldrin	0·5	1
Chlordane	2·0	4
Lindane	0·5*	1
Gammexane	0·5*	1
DDT	3·0	5

* Gamma-isomer content only.

If only small quantities of preservative, are required it is usually more economical to purchase a proprietary brand than to mix the chemicals. Suitable preservatives containing one or more of these insecticides may be purchased at most hardware stores.

Avoid using preservatives with a strong or persistent odour, such as creosote oil, and water-borne salts, which may cause swelling or warping, when treating Anobiid attack.

Special Cases

Advice on treatments to meet special requirements may be obtained from the State Forest Services, or from the Division of Forest Products, C.S.I.R.O., P.O. Box 18, South Melbourne, S.C.5.

PROPERTIES OF AUSTRALIAN TIMBERS

White Stringybark

WHITE STRINGYBARK is the standard trade common name for the timbers known botanically as *Eucalyptus scabra* syn. *E. eugenioides* and *E. globoidea*. In Queensland it is also known as pink blackbutt from its resemblance to blackbutt (*E. pilularis*).

Habit and Distribution

White stringybark is an erect, slim-boled tree of small to medium size, reaching from 40 to 100 ft in height and up to 6 ft in girth. The bark is very thick, loose, stringy, and fibrous, and persists to the ends of the branches. Its range extends from as far north as the Cape York Peninsula in Queensland to south-eastern Victoria. *E. scabra* prefers the coastal districts throughout its range but *E. globoidea* is confined to the central tablelands of New South Wales. *E. scabra* is plentiful around Cairns, Innisfail, and Gympie in Queensland, and throughout Gippsland in Victoria. It is met with occasionally throughout the rest of its range associated with white mahogany in the north and yellow stringybark in the south.

Timber

The timber is pale pink to brown in colour, usually straight-grained and free splitting, but sometimes interlocked. It is hard, tough, and strong, and has been placed in strength group B. It is comparatively light with a density of from 44 to 58 lb/cu. ft. at 12 per cent. moisture content with an average of 52 lb/cu. ft. before reconditioning, and 48·5 lb/cu. ft. afterwards. It is moderately durable but is not as durable as yellow stringybark. It works easily and can be steam bent at a 6 in. radius.

Seasoning

No major difficulties are likely to be encountered, although the timber is prone to collapse. Its shrinkage from green to 12 per cent. moisture content averages 10 per cent. tangentially and 5·5 per cent. radially. After reconditioning these become 5 per cent. and 3 per cent. respectively.

Uses

In Queensland white stringybark is used as a general building timber. In Victoria and New South Wales it is used for poles, sleepers, crossarms, general construction, and split posts and palings.

Availability

Kiln dried it is becoming more freely available as flooring and mouldings. The bark, after treatment, makes a very good substitute for sisal and coir fibres in fibrous plaster.

Upwards of 3 million super ft (sawn) are produced annually.

Fence Post Preservation

Use of Low-pressure Treatment Plant

THE DIVISION'S portable low-pressure treatment plant, described in Newsletter No. 200 (November 1954) has been widely used for demonstration purposes. During the summer of 1955–56 it was used to treat over 3000 posts with creosote oil, about half of these being radiata pine and the remainder various eucalypts. The simplicity of operation and reliability of the unit have been clearly shown and the effectiveness of the treatment on dry posts thoroughly established.

The treatments have also been valuable in establishing times necessary for different timbers to absorb the required amount of preservative. It appears that 24 hr is desirable for most eucalypts though some species can be treated in 12 hr. With radiata pine 4 hr is usually adequate and this can be reduced to 2 hr under favourable conditions.

Because of the demands of other work these demonstrations have had to be restricted, but several will be given this summer. The first of these will be given in conjunction with the Woods and Forests Department of South Australia at their Penola Plantation in January 1957. A large number of round pine posts will be treated, mainly with a water-borne preservative of the type which forms insoluble compounds in the wood soon after treatment.

There has already been considerable interest in South Australia in these forthcoming tests as, in a State where durable eucalypt posts are generally costly or difficult to procure, a reliable and cheaper round pine post is a most attractive alternative.

Demonstrations proposed for New South Wales during March will be mentioned in next month's Newsletter.

International Conference on Fibre and Particle Boards

AN INTERNATIONAL technical meeting on insulation board, hardboard, and particle board will be held in Geneva from January 21 to February 7, 1957.

The Conference is being called by two United Nations agencies, the Food and Agriculture Organization (F.A.O.) and the Economic Commission for Europe (E.C.E.), with the aim of providing their member countries with a better understanding of the technological and economic problems involved in the manufacture, use, and marketing of these products.

The scope of the conference is very wide, and it is hoped that the results of the meeting will clearly set out the many processes and techniques which are now available for the manufacture and use of insulating board, hardboard, and particle board, as well as indicate the likely future trend of development in these industries.

These discussions should therefore provide guidance to suppliers and consumers, also to others contemplating entry into this expanding business.

RAIL SLEEPER TESTS

The table summarizing the rail sleeper tests discussed in the December Newsletter will be published in a future issue.

DONATIONS

THE following donations were received by the Division during November 1956:

Mount Lyell Mining and Railway Co. Ltd., Melbourne	£200 0 0
N.Z. Forest Products Ltd., Auckland, N.Z.	£125 0 0
A. Dunstan and Son, Wodonga, Vic.	£100 0 0

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COMMON BORERS IN BUILDING TIMBERS

Part IV. The Pinhole Borers — "Ambrosia" Beetles

By J. BEESLEY, Wood Preservation Section

(*The information given in this article is intended primarily for use by sawmillers and timber merchants who are faced with the problem of controlling pinhole borer attack in logs and unseasoned timber.*)

THE BEETLES which bore into unhealthy or damaged trees, freshly felled logs, and unseasoned timber are known variously as "Ambrosia" beetles, pinhole or shothole borers, and, sometimes, as auger beetles. These beetles belong to three distinct families and vary greatly in size from minute insects to insects over an inch in length. Unlike the powderpost borers (Bostrychids and Lyctids) whose tunnels are confined to the sapwood where the larvae (grubs) feed mainly upon starch, pinhole borers tunnel into the heartwood, where the larvae of two of the families (Scolytids and Platypodids) feed upon a mould-like fungus—"ambrosia"—introduced into their tunnels by the adult beetles prior to egg-laying. The larvae of the third family of pinhole borers, the Lymexylids, do not appear to be dependent upon fungus for their nourishment and do considerably more tunnelling than the larvae of the Scolytids and Platypodids.

Pinhole borers occur in all tropical regions as well as in North America and Australia, where they are more active in warm humid weather than at other times. In regions where pinhole borers are prevalent it is usual to find that several species are present and that each contributes to any damage that occurs. Most control measures are dependent upon the fact that *all pinhole borers require green (unseasoned) timber for their development and that attack can be expected to continue whilst the moisture content of the timber is high and will cease when it dries.*

Recognition of Pinhole Borer Attack

Active pinhole borer attack occurs in trees and logs more commonly than in green sawn timber. Active attack may be recognized by the presence of "frass" (borer dust and excavated wood) accumulating on the surface of the infested timber. With some species the frass is ejected as dust which collects in small heaps, with others it is extruded as threadlike strands which may extend for an inch or two before breaking off, and which may be seen hanging from the borer holes.

Pinhole borer attack always causes some loss of quality in infested timber. This loss seldom matters with timbers intended for framing and similar uses, but may be of major economic importance in logs intended for veneering or peeling. The degrade which pinhole borers cause takes the form of small round holes, less than 1/10 in. in diameter, running across the grain rather than along it. The holes may be few and scattered, or very numerous and close together. The margins of the holes may be quite unstained, or they may be darkly stained by the "ambrosia"—in jarrah, a yellowish stain sometimes surrounds the holes.

Pinhole borer attack seldom causes a significant loss of strength in damaged wood unless it is associated with brittleness.

Control of Pinhole Borer Attack

Pinhole borer attack is commonly associated with sapstain or bluestain in Australian timbers, and control of the one is of little benefit unless the other is also controlled. Hence effective control should prevent both.

- In nearly all cases the incidence of sapstain and pinhole borer damage can be reduced by rapid extraction and quick conversion of the logs followed by proper stacking for seasoning. Once the surface of the timber has dried, there is little risk of new attack.

- In some areas the incidence of pinhole borer damage can be reduced, or even eliminated, by logging only in those periods when the borers are not prevalent. Unfortunately, reliable observations on the seasonal fluctuations in the population of pinhole borers in Australia are far too few for general recommendations to be made, and sawmillers must depend upon their own observations.

The cost of chemical spray treatments to prevent sapstain and pinhole borer attack is not likely to be justified unless logs are to be held in storage for a period of several weeks or months during the flight season of the borers. In special cases, treatment of logs which cannot be converted within a few days may be justified.

Whenever spray treatments are considered necessary, they should be applied within 48 hr of falling, and preferably sooner.

- In most areas best results will be obtained by barking the logs to be stored immediately after falling, and stacking them on skids on which they may be treated and where they may be left undisturbed until required for sawing.

Overseas, test results have shown that the protection afforded by some treatments can be prolonged if the treated logs are protected from sunshine and heavy rain.

In most cases, too, removal of the bark before treatment reduces the severity of attack. Cases have also been recorded in Australia, where barked logs have sustained more damage from pinhole borers than unbarked logs. Local experience must therefore be used in determining which is the better course to follow.

- Logs to be stored should be liberally sprayed on all surfaces and the ends with preservative, before end-coating. Treatment should be repeated whenever there is evidence of renewed borer activity. Few treatments are effective for more than a couple of months. However, if the attack is seasonal, this may not be serious.

- Creosote oil has given reasonable protection against pinhole borer attack under most Australian conditions, but research workers overseas have found that better results are obtained from preservatives based on the gamma isomer of benzene hexachloride (Gammexane, Lindane, etc.) in a mineral oil with the addition of a fungicide for sapstain control. Oil solutions have generally given more lasting protection than emulsions, although recent tests in West Africa have shown that a water-soluble Gammexane paint, which becomes water-resistant on drying, also gives protection for as long as 10 weeks.

- For treating logs, the preservative should contain at least 0·5 per cent. of the gamma isomer of benzene hexachloride in kerosene, diesel distillate, or diesel fuel oil, if water-soluble paints cannot be obtained. To this solution may be added from 3·0 to 5·0 per cent. of pentachlorophenol if sapstain control is also required. One gallon of this solution should cover 100–140 sq. ft of surface and be effective for 8–10 weeks.

- For the protection of sawn timber during the initial stages of drying, a water emulsion of benzene hexachloride (0·5 per cent. concentration, gamma isomer) with the addition of 0·5 per cent. sodium pentachlorophenate should prove satisfactory. This would be cleaner, though less permanent, than the oil solution used on logs.

- Dieldrin, at a concentration of 0·5 per cent., has been suggested as an alternative to benzene hexachloride, but test results have not yet shown it to be as good.
- Both benzene hexachloride and dieldrin may be purchased in the pure form and as emulsifiable concentrates from suppliers of agricultural chemicals and wholesale chemists.
- Other measures which may help to reduce the hazard from pinhole borers include burning, carting away, or spraying slabs, offcuts, etc., in the vicinity of the mill in which the borers might breed, and the use of "trap" logs (thinnings, milling waste, etc.) which may be used to attract the borers away from more valuable stocks. If trap logs are used, care must be taken to replace them whenever they become heavily infested.

Fence Post Preservation

DEMONSTRATIONS in New South Wales of the Division's portable fence post treatment plant are being arranged in conjunction with the N.S.W. Forestry Commission and a firm of preservative manufacturers. They will begin early in March at the Bombala (southern New South Wales) Agricultural Show.

From here the plant will be taken to the Lidsdale State Forest, between Lithgow and Bathurst, for a roadside demonstration of round eucalypt fence post treatment.

The demonstrations will not be confined to low-pressure soaking, which is more suited to large-scale or semi-commercial fence post treatment, but will also cover the hot and cold bath and cold-soaking methods recommended for the average farmer.

Let's Discuss Sawing

with D. S. JONES, Utilization Section

Good Gulleting

It might be considered that the elementary fundamentals of good gulleting are so well known that it is superfluous to mention them in an article such as this, but it is surprising how often saw teeth are gulleted with nicks, sharp corners, or ridges in them. This is definitely not good gulleting. Nicks and sharp corners produce stress concentrations which are often serious enough to start cracks in the plate, and all three irregularities break up the smooth flow of sawdust in the gullet and induce sawdust spilling. Some saw doctors obtain smooth well-curved gullets with a hand gulleting machine by using a wide stone dressed to the required curvature and which fills the bottom of the gullet. This is a commendable practice and it also makes it very much easier to grind all the gullets to the same shape.

High narrow teeth are not a good proposition on ripsaws that have to do anything like hard work. This type of tooth is occasionally used, especially when the saw is an old one considerably reduced in diameter. The trouble arises because the gullet depth has not been decreased proportionally with the decrease in tooth pitch. These high, narrow teeth are not as mechanically stable as the lower, squat type of tooth and vibrations can be set up within the teeth which adversely affect their cutting efficiency. Also, the lateral deflections of these teeth under load will be greater and the quality of the sawn surface must accordingly suffer. To determine the depth of the gullet a good rule, and one that is often used, is to maintain the gullet depth at about half the tooth pitch.

Summary of Rail Sleeper Tests

A SUMMARY of all rail sleeper tests conducted by or in cooperation with the Division is given on page 4. This summary is to be read in conjunction with the article on sleeper tests in the December issue of the Newsletter. More detailed information on any of the tests in progress may be obtained from the Chief, Division of Forest Products, C.S.I.R.O., P.O. Box 18, South Melbourne, Vic.

SUMMARY OF RAIL SLEEPER TESTS, JANUARY 1957

Railway System and Date Installed	Locality	Species under Test	Total No. of Sleepers	Details
W.A. Govt. Railways 1929	Bowelling, Bolgart, Southern Cross, Wyalcatchem	*Eucalyptus diversicolor*	3107	Fluarized sleepers treated and installed by W.A. Govt. Railways. This test has now been completed
S.A. Railways 1936	Mt. Gambier, Gladstone, Peterborough, Belair, Tailem Bend, Snowtown	*Pinus radiata*, *Eucalyptus rostrata*, *E. marginata*	1275	Eucalypt sleepers are untreated controls. Pine sleepers treated at low pressure with (1), (2), (12), and (13). Mt. Gambier and Belair sections of test now removed
W.A. Govt. Railways 1939	Dwellingup	*Eucalyptus marginata*	150	Surface coating of (1)
Victorian Railways 1941	Wallan, Wangaratta	*Eucalyptus bosistoana*, *E. rostrata*, *E. muelleriana*, *E. eugenioides*, *E. obliqua*, *E. goniocalyx*, *E. sieberiana*, *E. regnans*, *E. viminalis*	1800	Sleepers treated with surface coating of (1), with additional furnace oil spray on upper surface. Creosote sprayed on ballast
Commonwealth Railways 1952	Wirraminna, Nurina	*Eucalyptus diversicolor*	48	Treated at high pressure with (1) and (4)
Victorian Railways 1953	Melbourne (Flinders Street)	*Bruguiera spp.*, *Rhizophora spp.* (Mangroves ex New Guinea)	14	Treated with (1) (low pressure)
Tasmanian Railways 1954	N.E. line, Western line	*Eucalyptus obliqua*, *E. regnans*, *E. sieberiana*	146	Treated at high pressure with (1) and (2)
Victorian Railways 1954, 55, 56	Carnegie, Wangaratta, Heyfield, Korumburra	*Eucalyptus obliqua*, *E. regnans*, *E. eugenioides*, *E. australiana*, *E. rostrata*, *Pinus radiata* (ex Victoria and New Zealand)	3425	Treated (high pressure, low pressure, surface coating) with (1), (3), (4), (5), (6), (7), (8), (9), (10), (14)
Victorian Railways 1955	Heyfield	Six eucalypt species	306	Test of Macbeth rail spikes
W.A. Govt. Railways 1955	Bowelling, Merredin	*Eucalyptus marginata*, *E. diversicolor*, *E. calophylla*	569	Treated at high and low pressure with (1), (3), (10), and straight furnace oil
S.A. Railways 1956	Red Hill, Unley Park, Naracoorte	*Pinus radiata*	540	Treated at low pressure with (3), (5), (10), (14). Three sizes of sleeper under test
N.S.W. Railways (projected test)	—	*Tristania conferta*, *Eucalyptus sieberiana*, *E. obliqua*	300 (Approx.)	Probably (3) and (10)—high pressure
Queensland Railways (projected test)	—	*Eucalyptus grandis*, *Syncarpia hillii*, *S. laurifolia*, *Tristania conferta*	400 (Approx.)	Probably (1), (3), (11), and (14)—high pressure

Grand total: 12,080 sleepers (including 2285 untreated controls).

Low pressure treatments at 200 lb/sq. in. or lower; high pressure at 1000 lb/sq. in.

Preservatives listed in the table:

(1) Creosote; (2) Creosote : furnace oil—60 : 40; (3) Creosote : furnace oil—50 : 50; (4) Creosote : furnace oil—40 : 60; (5) Creosote : furnace oil—30 : 70; (6) Creosote : tar oil—40 : 60; (7) Creosote : naphthenic acid—20 : 80; (8) Naphthenic acid : diesel oil—80 : 20; (9) Pentachlorophenol in furnace oil (2%); (10) Pentachlorophenol in furnace oil (3%); (11) Pentachlorophenol in furnace oil (5%); (12) Tanalith U (fluo-chrome-arsenic-phenol); (13) Zinc chloride and arsenious oxide; (14) Greensalt K (copper-chrome-arsenic); (15) Copperized chromated zinc chloride (CCZC).

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Figure, Texture, and Grain of Wood

From a lecture prepared by R. F. TURNBULL, Officer-in-Charge, Utilization Section

WHEN DESCRIBING the appearance of a particular wood species, the four features commonly quoted are colour, figure, texture, and grain.

These features may appear in a description in this manner: "Colour pale to definite brown, grain straight or wavy and slightly interlocked, texture coarse, figure not prominent, but some fiddleback." The colour described leaves quite a definite impression, but what of the other features? Is the reader quite clear as to the difference between grain and figure or texture?

Since these features are of considerable importance in the grading and selection of timber, especially for furniture, joinery, and similar purposes, the following notes have been prepared to act as a guide to all concerned.

Figure

Figure refers to the pattern produced on longitudinal surfaces of wood resulting from one or a combination of three characteristics: (1) the arrangement and relative dimensions of the tissues, (2) the nature of the grain, and (3) colour variations. The interrelation of these results in almost infinite variation is figure. It may be enhanced by the plane of cutting. Backcutting and quartercutting give different figuring in timbers showing marked differences in the early and late wood of their growth rings, and veneer manufacturers particularly pay close attention to the direction in which a log or flitch of figured wood is cut, so that the most effective material can be produced. The art of matching is highly developed for the production of fancy plywoods, decorative panels, and flush doors. The highest development is probably in marquetry, and some specialists produce pictures out of wood, taking advantage only of natural figuring.

The manufacturers of some other materials pay wood a compliment by imitating the figuring of some attractive wood specimens and transferring it by the photographic veneering process to their product.

Texture

Texture refers to the relative size and amount of variation in size of the cells. We use the terms *coarse*, *fine*, *even*, and *uneven* texture in relation to wood. The differentiation between coarse and fine texture applies to hardwoods and is made on the dimensions of the vessels and the width and abundance of the rays. Timbers in which the vessels are large or the rays broad are said to be of coarse texture (e.g. silky oak), but when the vessels are small and the rays narrow, the timber is said to be of fine texture (e.g. coachwood). The even and uneven texture may be found in either softwoods or hardwoods. Softwoods such as Douglas fir, where the contrast between the early wood and late wood in the annual ring is very clearly marked, are usually termed *uneven* in texture, as are the ring porous hardwoods like red cedar, whereas softwoods with little or no contrast between early and late wood in the growth ring (e.g. hoop pine) or diffuse porous hardwoods (e.g. sassafras) are said to have even texture. Woods of fine or even texture are generally the easiest to stain and polish and are preferred for manufacturing purposes; coarse or uneven texture may be chosen for some decorative effect.

Grain

Grain and texture should be used to refer to two quite distinct characters of wood, but more often than not they are confused in everyday use.

Grain should refer to the direction of the fibres and associated wood elements relative to the axis of the tree or the longitudinal edges of individual pieces of timber, and texture, as we have seen above, refers to the relative size and the amount of variation in size of the cells.

The term "grain" is incorrectly used in a number of ways, for example, edge grain, or vertical grain is used to refer to timber that is cut so that its width is at right angles to the growth rings, i.e. parallel with a radius or the medullary rays; the term *quartercut* is much better and is now widely used in Australia. Similarly, timber cut with its width parallel with the growth rings may be described as *flat-grained*, but should be known as *backcut*—a term which is widely used in Australia.

In hardwoods, coarse and fine grain are frequently applied to characteristics that depend on the size of the elements and therefore, as previously mentioned, are more properly described as texture. In softwoods, coarse and fine grain is used to describe the width of the growth rings, the former to wood with broad annual rings, and the latter to wood with narrow annual rings. This feature is neither grain nor texture and is better described as fast- or slow-grown.

Timber that breaks with a short brittle fracture is often described as "short in the grain." The description is inept as the failure has nothing to do with the length of the fibres, nor is it connected with their direction in relation to the vertical axis of the tree, but with their brittleness, i.e. the readiness with which the fibre walls fracture at right angles to their length. Brittleness may be an inherent property of the species or it may be caused by such factors as fungal decay, brittle heart, exceptionally low density (for the species), compression wood, or even maltreatment in seasoning. The brittle fracture should not be confused with the type of fracture that may occur in cross-grained timber.

Using the restricted meaning of the term the following types of grain may be distinguished:

- *Straight Grain.*—The fibres or other main elements are practically parallel with the axis of the tree. This type is desirable for structural timbers, bending stock, handles, and some other manufactured items.

- *Sloping grain.*—Elements are not parallel with the long axis of the piece. Its effect varies with the severity and manner in which the slope occurs, as discussed and illustrated in Trade Circular No. 48, "Sloping Grain in Timber." This distinguishes:

  (*a*) cross grain,
  (*b*) diagonal grain,
  (*c*) spiral grain,
  (*d*) interlocked grain, and
  (*e*) wavy grain.

Sloping grain in its various forms may:

- Reduce strength.
- Increase tendencies to distort in seasoning.
- Accentuate difficulties of machining.
- Enhance figure.

To detect sloping grain a close examination needs to be made of the direction of the pores and wood elements. Coarse pores, surface checks, and wetting with drops of a coloured liquid may be useful aids; the pattern of the growth rings may be misleading.

The explanations provided in this article should leave no doubt as to what each term implies, but further information is given in Trade Circulars 43, "Figure in Timber," and 48, "Sloping Grain in Timber," both of which may be obtained by writing to the Chief, Division of Forest Products, C.S.I.R.O., P.O. Box 18, South Melbourne.

RECENT DEVELOPMENTS IN WOOD PRESERVATION IN AUSTRALIA

SINCE ITS INCEPTION, the Division of Forest Products has striven towards the establishment of a preservation industry in Australia. The logical first step in this development is the preservation of round poles for power and communication services. The savings to be achieved in this field are both immediate and considerable, because preservation enables the use of cheaper low-durability poles which, once treated, will compare in service life with species of high durability.

This first step was achieved by the opening, at South Grafton, N.S.W., on January 23, of the first pressure plant for the treatment of poles in Australia, by the Minister for Supply and Defence Production, the Hon. Howard Beale. The plant is operated by Hickson's Timber Impregnation Co. (Aust.) Pty. Ltd., which is associated with a large group of companies engaged in timber preservation in various overseas countries. The opening ceremony was watched by a large gathering of representatives of timber suppliers, timber-using organizations, forest services, and other interested parties from all over Australia. The plant in its present stage comprises a pressure cylinder, 70 ft long and 6 ft in diameter, with all necessary storage tanks, pumps, etc., pole-shaping and boring equipment, and handling equipment, with extensive pole storage and seasoning yards. It will initially be used for the Lowry treatment of air-seasoned poles with creosote, using a pressure of up to 200 lb./sq. in. By effective preservation of the sapwood of these poles, it will enable the use of smaller sizes and a wider range of timber species for poles for telegraph and power transmission lines throughout northern New South Wales and southern Queensland.

Pole treatment plants are also being set up by Hickson's in Wauchope (N.S.W.), Trentham (Vic.), and in Tasmania.

Victoria will be well served by preservation plants, as another well-known company, Saxton's of Moe and Licola, will soon commence operations at their pole treatment plant at Brooklyn, an outer Melbourne suburb.

PROPERTIES OF AUSTRALIAN TIMBERS

Tallowwood

TALLOWWOOD is the standard trade common name for the timber known botanically as *Eucalyptus microcorys* F. Muell.

Habit and Distribution

The tree may reach a height of 150 ft and a breast-high diameter up to 5 ft, and is found in the coastal forests of southern Queensland and northern New South Wales. Its range extends from the Hawkesbury River district north of Sydney to the Maryborough area in Queensland and to Fraser Island. The dark yellow to brick-red bark of the tree is fibrous, corrugated, and persistent to the smallest branches.

Timber

The timber varies in colour from light to dark yellow-brown and possesses a definite and distinctive greasy nature. From this latter characteristic has arisen the name tallowwood. The grain is usually interlocked, the texture moderately coarse, growth rings not distinct. At 12 per cent. moisture content the weight of tallowwood averages 62 lb./cu. ft. It is a hard, strong, and tough timber, and is rated as one of the most durable Australian hardwoods. The pale-coloured sapwood is moderately susceptible to attack by the Lyctus borer. The timber is comparatively easy to work by either machine or hand tools, turns moderately well, and presents no difficulties in staining and polishing.

Seasoning

In drying, 1-in. stock can be satisfactorily dried from the green condition. Backsawn boards have a tendency to surface-check, but these checks are generally fine and tend to close toward the end of the drying period. Warping is not severe. Although slight collapse may occur, reconditioning is usually not warranted, and is in fact not desirable, as steaming may cause fine checks to open.

Stock thicker than 1 in. should be given a preliminary air drying prior to final kiln seasoning. In drying from the green condition to 12 per cent. moisture content, tallowwood shrinks 6.3 per cent. in a backsawn (tangential) direction and 3.9 per cent. in a quartersawn (radial) direction, before reconditioning.

Uses

The timber is used for poles, crossarms, and turned spindles. Railway departments employ it for sawn and hewn sleepers, crossing timbers and transoms, bridge construction, and in the fabrication of carriages. In the building trade it is valued for stumps, bearers, joists, studs, window sills, and weatherboards. It is regarded as an excellent strip and parquetry flooring timber in domestic, industrial, and public hall locations. Other uses include paving blocks, mining skids and ore-sorting tables, agricultural implements, and planking, decking, and framing in ship building.

Let's Discuss Sawing

with D. S. JONES, Utilization Section

Safety Saws

A "safety" saw is not one which will not cut a finger off, but one which will not throw a piece of wood violently towards the sawyer. This dangerous characteristic of the orthodox circular saw is called "kick-back" and is likely to occur when a piece of wood accidentally contacts the back or top of the saw, or when the piece being sawn pinches severely against the rising teeth at the back of the saw and the piece is carried up until a tooth bites in and throws the wood towards the sawyer. As the teeth may be travelling at a speed of about 140 m.p.h., the wood is usually hurled violently and at high speed off the saw. The danger of contact with the saw is minimized by placing a guard over the top and a riving knife at the back so that as much of the saw as possible is protected. Further, the effects of pinching are lessened by the riving knife which tends to keep the sawn surfaces apart and by the quick use of a wedge as soon as pinching occurs.

A supplementary preventative is to design a tooth that will cut in the conventional manner, but will not bite deeply into a piece of wood which strikes the tops of the teeth. This has been done very simply by controlling the depth to which each tooth can cut. The number of teeth on the saw is reduced and the tips of the teeth project only a small distance out from the smooth periphery of the blade. This design was probably first introduced by Wilhelm Grupp, of Germany, under the trade name of "Wigo," but other firms now produce safety saws to the same design. The anti-kick-back feature of the saw has been well proved, and it has also been established that it consumes less power than orthodox designs.

Safety saws will be discussed further in a future article in this series.

DONATIONS

THE following donations were received by the Division during December and January:

Todd and Kerley Pty. Ltd., Huntingdale	£25
Perfectus Airscrew Co., Essendon	£5

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Forest Products Newsletter

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1957##229

NUMBER 229 MELBOURNE APRIL 1957

The Importance of Tannins and Other Phenolic Substances to Forestry

By W. E. HILLIS, Wood and Fibre Structure Section*

THE KNOWLEDGE of biochemistry (the chemistry of living things) collected during the past century has played a considerable part in the present rapid progress in medical and veterinary science. Much less attention has been given to the biochemistry of plants and in particular to the aspects concerning phenolic constituents, certain types of which are known as tannins. However, more research into these phenolic constituents is now being undertaken.

Until recently there was an increasing world shortage of vegetable tannin, but this trend has now been arrested. This relatively abrupt change is due to a number of factors.

The most important source of vegetable tannins is the quebracho tree of South America, and, as a reafforestation programme is not practicable with this slow-growing tree, it seemed that this source of tannin would disappear in the forseeable future. However, a survey of previously unexplored Chaco regions of the Argentine has just been completed and has revealed enormous stands of quebracho, the presence of which had not been suspected.

For many years it has been found that the climate and the labour conditions in Southern Africa are eminently suitable for wattle tannin production. Consequently, when the world shortage of tannin appeared imminent, an extensive wattle-planting project was commenced in that region, and the harvesting of these plantations has now commenced.

France and Italy manufacture a tannin extract from chestnut wood, and the cutting of their trees is carefully controlled. It appears that they will produce an exportable surplus for some time.

On the other hand, the chestnut forests in North America have been killed by a fungal disease. The last chestnut extract factory has just been closed, so that North America now has to import practically all its requirements. At the present time Australia also must import most of its tannin materials, costing approximately £750,000.

In addition to this changing picture in the supply of vegetable tannins, there are also changes in their uses.

* Last year the author visited laboratories in Europe, North America, and Japan.

Synthetic replacements for leather and increasing use of mineral and synthetic tannages have resulted in a decreased demand for vegetable tannins for leather production. A new solvent tanning process is under development in the United States in which the tanning medium is a mixture of wood rosin and tannin, where again less vegetable tannin is required.

As a result of the above factors production of tannin extracts has overtaken demand. However, this change in the supply position may be only temporary, as a reduction in the price of tannin extracts would enable leather to compete more readily with synthetic replacements, and in turn the consumption of tannin would again increase. In addition there is an increasing demand from people in the poorer and underdeveloped countries for leather, principally for footwear. The technicians in these countries are being trained in methods of manufacture of light-coloured leathers, and consequently the dark leathers produced by certain types of tannin extracts will be less acceptable.

As most of the tannins which could be produced in Australia and its Territories yield a dark-coloured leather, it is important to us that a number of new uses are being developed for tannin where colour is of no consequence. One interesting development is as a rust preventative, whereby a coating of tannin solution can be used to protect iron and steel during storage and transportation, and prior to painting. Tests carried out in England showed that an initial coat of tannin was much superior to many other rust preventatives. The iron tiles of the English Houses of Parliament were treated in this manner prior to painting. The rusting of underground pipes has been greatly reduced by treating with tannin, and the addition of small quantities to plastic paints has widened their applications and may help to prevent rusting of the containers.

Work in C.S.I.R.O. has shown that tannins can be used as a base for plywood adhesives. Investigations along similar lines have been commenced recently overseas, and the possibility of incorporation of tannins in improved plastic moulding powders has also been examined. Tannins are also used to render clay-water mixes more fluid in the oil-well drilling, ceramics, and brick industries.

Although the role of tannins in industry is a very important one, the phenolic substances may have an even greater significance in forest practice. Certain aspects of these compounds have been studied for many years, but their importance in the functioning of a tree has been largely overlooked. The study of them will assume greater importance as time goes on, and the knowledge gained should assist in obtaining better yields of higher-class timber from our forests.

Commercially, the heartwood is the most important part of the tree, but we know very little about why it is formed or the place of origin of the phenolic constituents which are characteristic of it. However, we do know that the phenolic constituents are largely responsible for the natural durability of wood, and variations in the amount of these are probably responsible for variations in durability between various species, and also between different trees of the same species. When the nature of these phenolic constituents is known a method of analysis could be devised so that the natural durability of wood could be assessed very rapidly.

These constituents also play an important part in the living tree. It would seem that those trees containing only small amounts are more likely to develop rot and other defects, and be more prone to disease generally. More knowledge of the phenolic constituents might enable us to leave in a young plantation only those trees of the highest quality.

As time goes on, the increased knowledge of the biochemistry of plants, which we will gain from these studies, will enable us to overcome many existing problems, and then to improve the quality of our forests so that we can obtain the products most suited to our requirements.

DONATION

THE following donation was received by the Division during February:

Andrex Pty. Ltd., Mordialloc	£26 5 0

DISCOLORATION OF WOOD AND NATURAL WOOD FINISHES

THE MODERN trend towards blonde furniture has been accompanied by the desire to obtain a similar finish on architraves, skirtings, ceilings, wood panelling, and other built-in household wooden fittings. The blonde finish on furniture is achieved by the selection of light-coloured timber, by a bleaching process, or in many cases by a combination of selection and bleaching. The furniture is delivered from the manufacturer with its surface protected by some type of clear polish.

The position as regards architraves, skirtings, etc. is very different. Some of the best blonde woods are too expensive to be used for these purposes, selection is limited to quality with little attention to colour, and some of the bleaching methods used for furniture are not always practical. Also the timber is delivered to the site in its finished condition but still requires cutting to size and fitting. This additional handling may result in some soiling of the wood which must then be sanded to remove any dirty marks. The timber may also be marked during storage by exposure to weather, with subsequent darkening and water staining. In addition to these stains our light-coloured eucalypts, which are used extensively for interior fittings, develop a blue-black stain on coming into contact with iron in the presence of even small amounts of free water. These stains may develop when passing the dressed wood over a slightly damp steel saw bench or planing table, by wetting with water that has passed over iron fittings, by coming in contact with iron tools or iron filings, or even when handled by people who are also using iron tools, fittings, nails, etc. The possibility of staining is always greatly increased during wet or humid conditions. Iron stains may also develop around nail holes or from other iron fittings in contact with the wood.

The method generally used for the partial blonding of interior woodwork has been to apply a concentrated solution of oxalic acid. When the wood has dried it is brushed to remove oxalic acid crystals, washed with clean water, and when quite dry coated with a clear finish. Oxalic acid bleaching sometimes introduces finishing problems but in general it produces the desired bleaching effect. Any dirty marks on the wood of course appear darker by contrast. In addition to bleaching the wood the oxalic acid reduces the blue-black iron stain to an almost colourless iron compound.

During the past winter a number of cases have come to hand where wood which has been bleached with oxalic acid for interior fittings has appeared subsequently to develop iron stains. Investigations showed that this wood had received the iron stain during handling and storage. These stains were removed during the bleaching treatment with oxalic acid but in cases where the iron staining was deep seated there was some reversion of the iron stain. *Laboratory tests confirmed that this effect was aggravated when bleached shellac was used as a clear finish.*

To understand the reason for this result it is first necessary to examine the way in which oxalic acid removes iron stains. The oxalic acid reacts with the iron to produce a colourless compound by reducing the iron from the ferric to the ferrous state; it does not destroy or remove the iron. The colour may be restored by any oxidation treatment, and the colour will slowly return on prolonged exposure to air. When bleached shellac is applied the possibility of colour reversion is increased because of the presence of traces of bleaching powder (a powerful oxidizing substance) which is used for bleaching the shellac.

This experience helps to emphasize the importance of preventing staining of wood that is to be clear finished. The procedures used to remove most types of stain are generally successful, but when stains are severe or have existed for long periods the chances of successful removal are small. The only safe procedure is to avoid staining, and this can be done by careful storage and handling of all timber used in interior fittings and by applying the clear finish as soon as possible after the woodwork has been placed in position. Nails should be punched and sealed as soon as possible to prevent iron stain developing around nail holes if there is any possibility of the wood becoming damp or wetted with water. All these precautions may necessitate careful planning but they can help to avoid expensive remedial treatment which may be only partly successful in the removal of various types of stains. Further, care should be taken when selecting the clear finish to ensure that it will not cause colour reversion and thus reduce the effectiveness of any bleaching or chemical treatment.

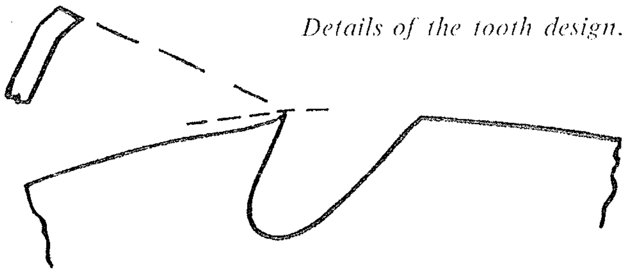
Let's Discuss Sawing

with D. S. JONES, Utilization Section

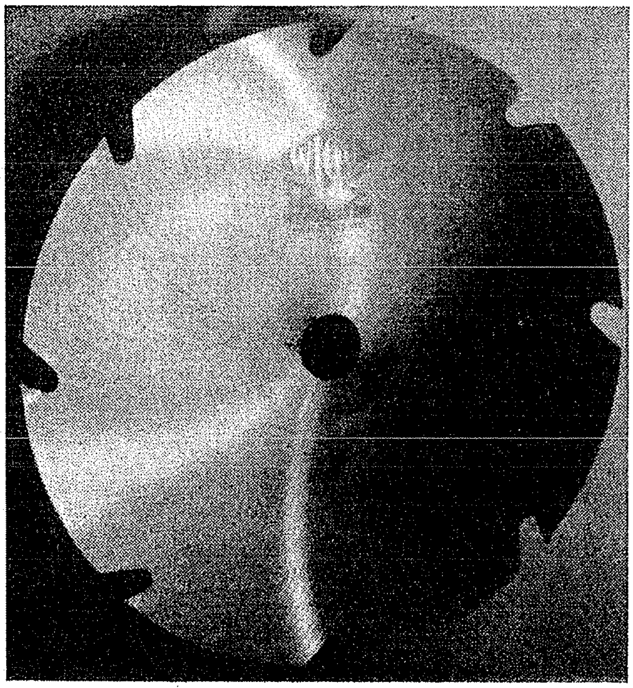
More Facts About Safety Saws

The "Wigo" safety saw made by Wilhelm Grupp is intended to be a precision wood-working tool giving accurate dimensions and high-quality sawn surfaces, which for many applications in the furniture and cabinet industry eliminates the necessity for planing. The blades are therefore made of heavier-gauge plate than conventional saws the same diameter, the normal gauge of a 16-in. diameter "Wigo", for example, being 13 BWG against 16 BWG for orthodox saws. As these blades have only 16 teeth, grinding and setting must be done very accurately to ensure that each tooth does its job cleanly.

All of the solid-tooth safety saws produced to Grupp's original design are spring-set and the teeth have no top or front bevel. The safety design can be applied to ripsaws, cross-cut saws, and combination saws. The teeth on the ripsaws have a hook angle of 30°, and a 16-in. ripsaw has 16 teeth. Cross-cut saw teeth have hook angles between 0° and 5° with no front or top bevel, and 16-in. diameter blades have either 20 or 24 teeth. The values applied to combination saws lie in between these limits.



Details of the tooth design.



A 10-in. diameter safety saw.

Safety saws are usually run at fairly high speeds, rim speeds of the order of 12,000 to 13,000 ft/min often being recommended.

One of the principal deterrents to the more extensive use of safety saws is the specialized grinding technique which is required. This difficulty is best overcome by agents arranging for a central saw-sharpening service to be available, and some agents now operate such services. The special sharpening technique also limits the diameter of these saws, the largest sharpening machine made by Grupp having a 30-in. capacity only. This is unfortunate because the safety feature is more important on the larger saws used in sawmill breast benches than on small woodworking saws. Also it is only with large saws used in production benches that the power saving claimed for these saws would become significant.

However, as a precision woodworking tool safety saws have a place in industry and they are being used in increasing numbers, especially in applications that require tungsten carbide tips, as the design lends itself admirably to carbide tipping.

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Forest Products Newsletter

1957##230

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NUMBER 230 MELBOURNE MAY 1957

Dimension Stabilizing Treatments For Timber

By G. W. WRIGHT, Officer-in-Charge, Seasoning Section

THE BASIC cause of shrinkage* in wood was discussed in Newsletters No. 184 and 186. Its occurrence was ascribed to the strong attractive force between hydroxyl groups of adjacent cellulose components (and lignin) as moisture diffused from cell walls during drying.

Shrinkage and swelling in wood are, therefore, phenomena caused by the loss or absorption of moisture, either in the liquid or vapour phase, from or into the structure of the cell wall. As described in Newsletter No. 180, its effect on the shape or dimension of any particular piece of wood can generally be anticipated from a knowledge of its fibre structure and its cell orientation. Many of the forms of warp which occur during drying are manifestations of shrinkage in cross- or spiral-grained wood, reaction wood, and core or pith wood; or are due to differences in shrinkage in the radial and tangential directions or the early and late wood of individual growth rings.

Dimensional change, or instability during manufacture, can also be caused by unrelieved drying stresses within seasoned wood. These are basically due to different rates of shrinkage in different parts of the one piece of wood, and result from the moisture distribution pattern assumed by the wood under particular drying conditions.

Whatever the form in which dimensional movement takes place, or however distortion is emphasized during drying or manufacture, it is clear, then, that the stability of wood is dependent on either (i) the dimensional response of the timber to a changed or changing moisture content condition, or (ii) to the influence of unrelieved drying stresses.

Instability due to drying stresses generally becomes apparent during shaping or manufacture, and, while it may result in rejection during inspection after manufacture, it is not generally a major factor in subsequent movement during use unless the timber concerned is further altered in size or shape by cutting or paring. Losses due to this cause in articles for highly critical use can be very high unless the timber is thoroughly relieved of stress during the seasoning process. Stress relief can be achieved by a high temperature–high humidity treatment in

* As used in this text, shrinkage does not include dimensional change from collapse.

kilns, and this usually incorporates a treatment for equalizing the moisture content.

Poor seasoning practice, leading to a poor moisture distribution at the time of manufacture, can also be responsible for subsequent movement, although this may not be noticed until some time after manufacture. The importance of a final equalizing treatment at the conclusion of seasoning cannot be over-emphasized.

Even though we may have timber free from stress and with a satisfactory moisture distribution at the time of manufacture, dimensional change will still occur as a result of change in atmospheric conditions. In fact, dimensional instability in wood in service is almost always due to a moisture change. As relative humidity rises the wood moisture content tends to rise and the wood to swell; as relative humidity drops the wood moisture content tends to decrease and shrinkage to take place.

What, then, can be done to restrict dimensional change in wood?

There are five recognized basic methods for reducing movement in wood. These are:

(*a*) *By external coatings* superimposed over the entire exterior surface of the wood: the most common are paints, waxes, varnishes, and resins.

(*b*) *By penetrating liquids or compounds* which coat the internal microscopically visible capillary surfaces: these are usually oils, waxes, and resins.

(*c*) *By heating*, the effect being a reduction in hygroscopicity: this is the simplest and cheapest method so far developed to give anti-shrink behaviour.

(*d*) *By bulking agents* which penetrate the intimate fibre structure and keep the wood swollen to a size above normal for the particular conditions of exposure: possible materials are salts, sugars, or synthetic resins.

(*e*) *By chemical agents* which react with the hydroxyl groups of the wood lignin or cellulose or both. For example, the anti-shrink effects of acetylation, and of phenol-formaldehyde resin deposition are believed to be partly chemical and partly bulking.

Of the above methods (*a*) is generally regarded as more reliable than (*b*), provided no abrasion is involved. It is impossible to ensure that waxes and oils will coat completely even the microscopically visible capillary structure of wood; and, although the coating material may itself be water resistant, on exposing the treated wood to water this can find its way between the coating and the wood material. The deposition of oils or waxes can, therefore, retard the absorption of moisture and give useful temporary protection, but cannot prevent its ultimate absorption. In fact, if the exposure to water is long enough, wood treated in this way can swell to a value beyond that of the original green dimension.

Normal dips or soaks usually do not give much more than a surface treatment, and a hot-and-cold bath treatment at least (failing pressure treatment) would be necessary to get significant absorptions into hardwoods. With oils and waxes there is also the risk of "weeping" under high temperature conditions. These treatments are, however, comparatively low in cost and, as indicated, are effective for timber under semi-protected conditions, or subject to only short-term changes.

Heating (method (*c*)) is effective in reducing dimensional change but to have useful effect needs to be carried out at such a high temperature, or for so long at a lower temperature, that it is generally accompanied by pronounced embrittlement and loss in abrasion resistance and shear strength, although modulus of rupture is not greatly affected. The anti-shrink effect is associated with the loss of water of constitution, and is thus dependent on the weight loss of the wood during heating. Studies by Stamm* have shown that anti-shrink efficiencies greater than 45 per cent. cannot be obtained by heating in air, and that this is accompanied by a weight loss of about 20 per cent. The effect is thus primarily chemical.

The bulking effect of the inorganic salts, as under method (*d*) can be considerable. Stamm has also shown that the amount of stability given is dependent on the solubility of the salt and the slowness with which the wood is dried after soaking; and that, in general, the anti-shrink characteristics increase directly with increasing surface tension,

* Subject Matter Specialist, U.S. Forest Products Laboratory, Madison, Wisconsin.

and inversely with the vapour pressure of the solution. However, salt-treated wood has certain disadvantages. These are (i) the salts can be leached, (ii) they can be corrosive to metals, and (iii) they are likely to cause the wood surface to become damp on exposure to high humidities, i.e. when the relative humidity is higher than the equivalent reduced vapour pressure of the salt solution. For many of the salts, leaching simply causes a return to normal shrinkage–moisture behaviour. However, any chemical such as as a catalyst. This treatment gives an extremely high permanent degree of stabilization and does not embrittle the wood. For other than thin material, such as veneers, or sections very short in the grain the acetylation time required is, however, considerable. For example, a 6-hr treatment at nearly 200°F was required to give a 70 per cent. anti-shrink effect on $\frac{1}{16}$-in. thick hardwood veneer. Treatment time for other thicknesses would probably vary as the square of the thickness.

Fully air-dry log disks of Grey Gum (E. goniocalyx) *showing the effectiveness of Carbowax as a stabilizing agent.* ***Left:*** *Untreated control disk soaked in water for 76 days and then allowed to dry.* ***Right:*** *Matched disk soaked in Carbowax for 76 days and then allowed to air dry.*

sodium hydroxide which gives a swelling effect on absorption, but which hydrolyses wood, could probably increase shrinkage under leaching conditions because of the simultaneous removal of wood extractives.

Sugars are better bulking agents than salts because of their greater solubility. Their vapour pressure reduction is also less, so they have a lesser tendency to make the wood damp, and they are also non-corrosive. They can make the wood more subject to decay unless decay-inhibiting chemicals are added to the treating solutions.

Acetylation, the replacement of cellulose and lignin hydroxyl groups with acetate groups (a bulking and chemical technique), is best carried out with acetic anhydride in the vapour phase in the presence of pyridine

The most effective commercially practicable anti-shrink treatment of a permanent nature is given by depositing synthetic resin condensation products such as phenol-formaldehyde within the wood structure. The effect is partly bulking and partly chemical. By this treatment shrinkage and swelling can be reduced to about 25 per cent. of normal by depositing resin to the extent of about 40 to 50 per cent. of the wood weight. The treatment does, however, cause some embrittlement, so that shock resistance may be somewhat decreased. Leaching conditions do not effect the permanency of the treatment. The resin must be a very lightly condensed one.

Carbowax (polyethylene glycol) is another recently recognized bulking agent which is also extremely effective in that it can almost eliminate shrinkage because of its high solubility in water. Stamm points out that it can completely replace water in the swollen structure of wood. Carbowax can, however, be leached from wood fairly easily unless fixed by the addition of an equal weight of phenolic resin. Under these conditions it has given anti-shrink efficiencies ranging from 60 to 80 per cent.

Strength Properties of Australian and New Guinea Timbers

FOR MORE THAN 25 YEARS the Division of Forest Products has been conducting mechanical tests in its Timber Mechanics Laboratory on local and other timbers. Although a wide range of timbers has been examined, there is, as might be expected, a considerable variation in the amount of information obtained on the individual species. In some of the more important structural timbers, tests have been made on as many as 30 trees or more of the one species, whereas with some minor timbers perhaps one or two samples only have been examined.

Based on these investigations, a Bulletin has now been published in which detailed information is given on the properties of 85 Australian and 13 New Guinea timbers, and also ramin and keruing from Borneo and Malaya respectively. The properties covered include density, compression and shear strength, shock resistance, and hardness. Only those timbers have been included for which at least three trees have been sampled. In addition to the average properties, various statistics have also been tabulated giving a picture of the variability of individual species and the precision with which the species average properties have been estimated.

The information given in Bulletin 279 has been compiled for the use of wood technologists rather than for those engaged in the design of structures, and should be of considerable value to overseas laboratories and to those intimately associated with the utilization of Australian timbers.

Recent Tests on Nails

By J. J. MACK, Timber Mechanics Section

SOME INTERESTING RESULTS have been obtained in a series of tests recently concluded at the Division on the holding-power of case nails. The series was designed to examine in detail the holding-power of plain and cement-coated nails in radiata pine, mountain ash, and karri, and in all 10,368 individual withdrawals were made. Nails of various gauges were driven into timber at different moisture contents and were pulled either immediately or 3 months later at the same or a lower moisture content.

The most important conclusion reached was that the cement-coated nail is about 70 per cent. superior to the plain nail in dry or semi-dry radiata pine, but there is no advantage as regards holding-power in using a coated nail in mountain ash or karri. It was further found that the moisture content of the wood at the time of driving has a considerable effect on the immediate holding-power, but that this effect varies with the species and kind of nail. Also, in general, the initial moisture content has an important bearing on the final holding-power after the timber has dried. On the whole, dry timber appears to give the best results for all species tested and for both types of nails. It was verified that holding-power is linearly related to nail diameter and penetration.

It may be of interest to note that in a current series of tests the holding-powers of special types of nails with rolled threads are being compared. Another series is being carried out to examine "nail popping", a problem which is particularly troublesome in the fixing of wall boards.

LAMINATED SKIS
—how to make them

By D. S. JONES, *Utilization Section*

LAMINATED SKIS have created considerable interest and every winter the Division of Forest Products receives a number of enquiries about the design of laminated skis and the methods used to make them. As well as being lighter than solid skis of equivalent wearing qualities, laminated skis retain their shape better than steam-bent skis. In addition, it is much easier to control the size and position of defects when the ski is made up of several laminations, and the effects of sloping grain are reduced.

Various types of laminated skis have been tried over the years with varying degrees of success. One of these designs has been described by Hebblethwaite (1949). As a result of accumulated experience a design has been developed which strikes a reasonable compromise between ease of construction and satisfactory service characteristics. It consists of a bottom and a top lamination of a heavy, good-wearing species and between these is a core, shaped like a double-ended wedge. The core is made of a lighter species than the top and bottom laminations to reduce the overall weight of the ski. This article describes this particular type of laminated ski and gives a method of construction suitable for the amateur ski maker. Booth and Humphreys (1956) have also devoted attention to the same type of ski.

Material

The most popular species for top and bottom laminations is spotted gum (*Eucalyptus maculata*). However, Sydney blue gum (*E. saligna*), brown tulip oak (*Tarrietia argyrodendron*), brown stringybark (*E. capitellata*), and crow's ash (*Flindersia australis*) have comparable wearing properties (Hebblethwaite 1948) and are also satisfactory. The species for the core can be selected from Vanikoro or Queensland kauri (*Agathis* sp.), hoop pine (*Araucaria cunninghamii*), sassafras (*Doryphora sassafras*), or radiata pine (*Pinus radiata*). Any knots in pieces of radiata pine should be small and firm and should not extend to the edge of the piece.

Material for the laminations and core should have a moisture content no greater than about 12 per cent. at the time of dressing, and it is therefore preferable to cut the laminations and core from kiln-dried stock.

A limited number of defects are allowable on hidden faces. For example, small gum veins, splits, tight knots, etc. can be tolerated to a limited extent as long as they do not reach to the edge of the ski. The running face, however, should be perfectly clear if possible, and no defects should be allowed at the bend. It is essential to select timber that is as nearly as possible straight grained. Also brittle wood must be excluded. This defect can be detected by lifting the fibres with a knife; if they break across their width in a "carroty" way the piece must be rejected. Quartersawn (on an end section the growth rings are across the thickness) top and bottom laminations probably give better wearing properties, but a backsawn (growth rings across width) core will be more resistant to splitting when fittings are screwed to the ski.

The most satisfactory glue has been found to be Beetle Cement "A" with hardener 30. This is a gap-filling cement manufactured by Beetle Elliot Ltd., and 540 g ($1\frac{1}{4}$ lb) of glue is required for a pair of 6 ft 8 in. skis.

Dimensions of Skis

Ski measurements vary a great deal from pair to pair, some skiers preferring long skis, others short, some wide, and others narrow. Measurements depend also on the use to which the ski is to be put. A cross-country ski for example, is somewhat narrower and lighter than a downhill ski. Measurements given in Figure 1 have been proved satisfactory for a general-purpose laminated ski. The length, *L*, depends upon

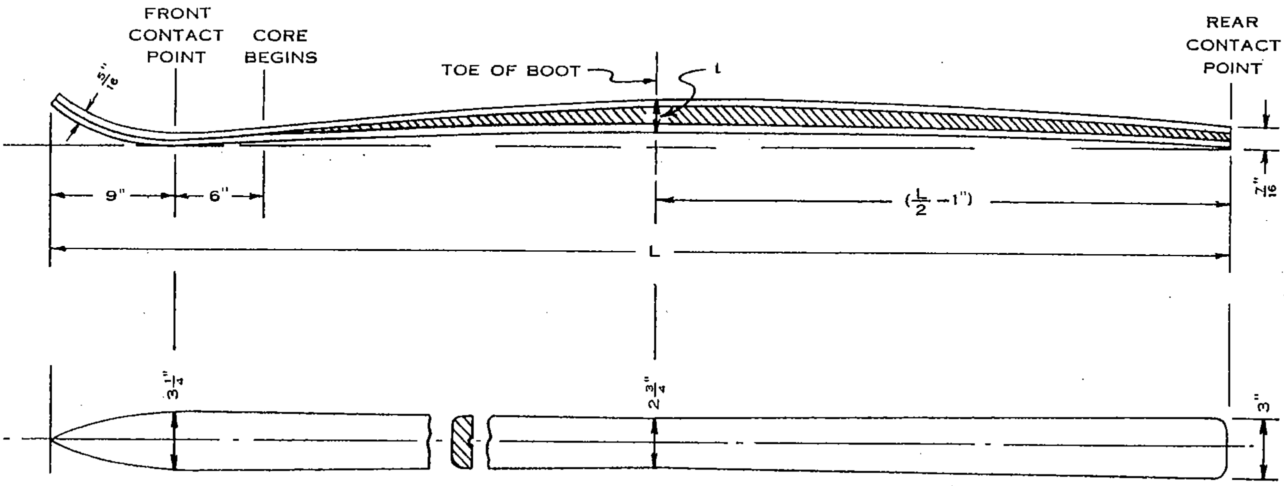

Fig. 1.—Dimensions of laminated skis (not to scale). For values of E and t, see text.

the height of the owner, and is about 6 ft 11 in.–7 ft for a person 6 ft tall decreasing to about 6 ft 8 in.–6 ft 9 in. for a person about 5 ft 8 in. tall. A rule of thumb which is widely adopted for calculating the correct length of a ski is to take the length equal to the height from the floor to the owner's cupped hand held overhead. A recent trend is to make skis slightly shorter, the length being the individual's height plus 9 in.

The laminations to be used should be obtained in lengths 6 in. in excess of the finished length of the ski and should dress to $\frac{5}{32}$ in. thick. The shape and dimensions of the core are illustrated in Figure 2. The depth, *d*, of the core depends upon the length of the ski and should be $\frac{9}{16}$ in. for skis 5 ft 9 in.–6 ft 3 in. long, $\frac{11}{16}$ in. for skis 6 ft 3 in.–6 ft 9 in. long, and $\frac{3}{4}$ in. for skis longer than 6 ft 9 in. This makes the corresponding ski thicknesses, *t*, $\frac{7}{8}$ in., 1 in., and $1\frac{1}{16}$ in. respectively.

Gluing Press

A gluing press is shown in Figure 3. The frame consists of a large member of dimensions 4 in. by 4 in. by 7 ft which should be reasonably straight grained and dry, so that twisting or bowing will not take place after the press is assembled. Douglas fir is an excellent timber for the frame. The top and bottom curved portions at the toe of the ski can be cut simultaneously from a solid block of dimensions 12 in. by 6 in. by $4\frac{1}{2}$ in. to the profile indicated in Figure 4. The bottom member of the press is $4\frac{1}{2}$ in. by $\frac{11}{16}$ in. by 6 ft 9 in. and is screwed onto blocks fixed to the frame. It is $\frac{3}{4}$ in. higher in the centre than at its ends, the best curvature being the natural curvature produced when the piece is bent over the centre block and fixed at each end. The pressure blocks are cut from 3 by $1\frac{1}{2}$ in. hardwood and are 8 in. long.

Gluing up the Ski

If either spotted gum or crow's ash is used for the top and bottom laminations, the surfaces to receive glue should be lightly sanded with a fine sandpaper immediately before gluing to remove the slightly oily surface that is characteristic of these species.

After spreading glue on all surfaces except the two outer ones the laminations and core are assembled in the press. It is wise to lay paper between the press faces and the ski to prevent them adhering. When the three pieces are in the correct positions they can be prevented from sliding during subsequent operations by pinning them down with two thin brads hammered through the press at the extreme heal of the ski. These brads are easily removed when the ski is later taken from the press.

The top member of the press is laid over the ski and is temporarily held in position with a G-clamp at either end. The pressure blocks are then bolted down commencing from the heel of the ski and progressing toward the bend. When the top member is in position the heavy curved piece at the bend is bolted down. A more uniform pressure at the bend is obtained if a strip of rubber $\frac{3}{8}$ in. thick is laid between the ski and the top curved block. Extreme care must be taken to ensure that a good uniform pressure is applied to the ski around the bend and right out to the tip. This portion of any ski breaks during service more than any other part and with laminated skis it is the section that most often fails due to faulty gluing. The press clamps at the bend should be supplemented by G-clamps to help distribute the pressure.

The time taken between spreading the glue and bolting down the final clamp should not be greater than about 30 min when the air temperature is 70°F. If the air is cooler more time can be taken, but it is always best to try and have clamping completed within 30 min. The pressing time necessary for Beetle Cement "A" with hardener 30 is 4 hr at 70°F. If the air temperature is 50°F this time must be increased to 12 hr. Experience has shown that it is safer to leave the ski clamped up for at least 12 hr when the average air temperature is 70°F and for at least 24 hr (longer if practicable) if the average air temperature is as low as 50°F. However, it is best to avoid temperatures lower than 60°F when gluing up, and the use of a warm room may be necessary.

Finishing Off

All the shaping processes can easily be undertaken using hand tools (Booth and Humphreys 1956) but machines, of course, make the work much easier. If machines are used simple jigs need to be constructed to adapt the machines to the special requirements dictated by the shape of a ski. It is not intended to give detailed woodworking instructions in this article, but the following are a few hints that might assist the amateur ski maker.

The glued blanks should first be trimmed roughly along their edges to remove excess wood and glue, and then one edge of each ski should be planed to a straight line. This straight edge will be used as a reference face for the hand gouge or machine tool used to cut the groove which extends along the centre of the running face of the ski. The groove should be about $\frac{1}{8}$ in. deep and $\frac{1}{2}$ in. wide, and it begins 4 or 5 in. behind the front contact point and extends back to the heel of the ski. It should not be deeper than the thickness of the bottom lamination.

Using the groove as a centre-line, the plan profile is drawn on the skis and is then cut out. When the profile is being hand-planed it is a good idea to clamp the skis together with G-clamps and shape both skis at the same time. This ensures that both skis have exactly the same shape. Lifting of the grain, however, sometimes prevents this procedure.

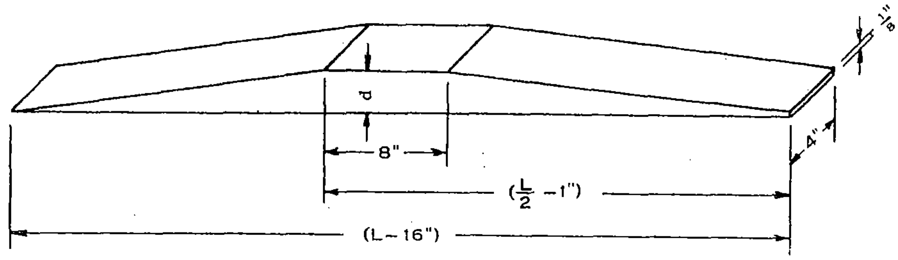

Fig. 2.—Core used in laminated skis (not to scale). For value of d, see text.

Fig. 3.—Gluing press.

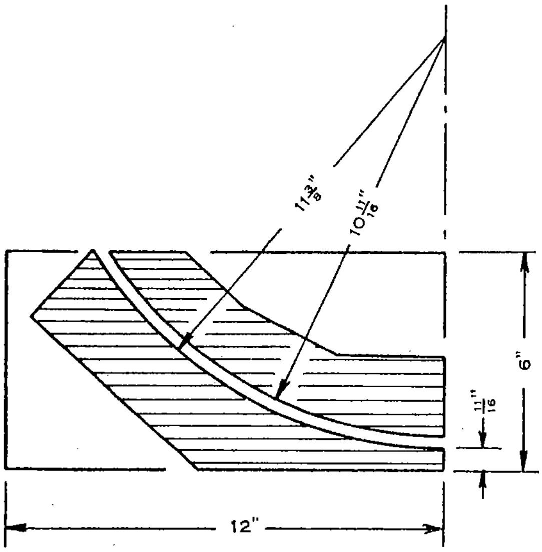

Fig. 4.—*Curved block for gluing press. The block was cut from a piece of wood* 6 *in. by* 4½ *in. by* 12 *in.*

The edges of the running surface are usually protected by steel strips rebated flush with the surface. These edgings commence about 5 or 6 in. forward of the front contact point and extend to the extreme heel of the skis. For simplicity, neither the edgings nor the groove have been shown in the figures.

Clear and pigmented enamels, especially marine enamels, have been proved satisfactory for finishing skis (Booth and Humphreys 1956) and plastic floor finishes are also good. The pigmented finishes seem to have better wearing resistance on the running surface. A minimum of three or four well-hardened coats are necessary on the running surface and it is often necessary to touch up the running surface once or twice each season, depending upon the severity of use. Ski waxes take reasonably well to most types of finish.

The bindings are screwed to the ski so that the toe of the skier's boot is in the position indicated in Figure 1.

If any de-laminating occurs due to faulty gluing it will usually occur at the extreme tip of the ski and it is a good practice to strengthen the tips of laminated skis with metal protectors. The best type to use is one that can be screwed on and then pinched up firmly to hold the laminations together.

A number of laminated skis have been made according to the design and method set out in this article and they have given satisfactory service. When the best selected timbers are used, a light, strong and reasonably flexible ski is produced.

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DONATIONS

THE following donations were received by the Division during March 1957:

Wilson, Hart and Co., Maryborough, Qld.	£157 10 0
Kauri Timber Co., Melbourne	£100 0 0
Commonwealth New Guinea Timbers Ltd., Bulolo	£1000 0 0
Hicksons Timber Impregnation Co. (Aust.) Pty. Ltd., Sydney	£100 0 0

It should also be recorded that we have received as donations the following items:

A 50-lb roll of "CreZon" plastic overlay for experimental work in the Plywood Investigations Section. The "CreZon" was received from the Crown Zellerbach Corp. of the United States, and the value is approximately $50.

An electronic moisture register unit from Monsanto Chemicals (Aust.) Ltd., the value of which is approximately $150.

A 14-in. bandsaw from J. Schubert & Son, Barranduda, Vic., the value of which is approximately £65.

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C.S.I.R.O.

Forest Products Newsletter

1957##231

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NUMBER 231 MELBOURNE JUNE 1957

COMMON FAULTS IN TREES

From a lecture prepared by R. F. TURNBULL, Officer-in-Charge, Utilization Section

WHILE there are undoubtedly magnificent trees in Australian forests, and foresters endeavour to improve continually the form of trees in every stand, it must be admitted that perfect trees are rare. During the course of their growth, trees are exposed to many hazards—storm and tempest, fire, insects, fungi, birds, animals, and machines. In addition to one or more of these, the growth habit of the tree itself, falling branches, or contact with neighbouring trees, vines, or parasites may cause some kind of injury, the effect of which is revealed when the trees are converted to timber. No forest can be utilized on the basis of extracting only undamaged, straight, and symmetrical logs. Sawmillers have to contend with faulty logs and have to find outlets for the material they produce. A greater understanding of sawmillers' problems by timber-using industries is desirable, so that joint efforts can be directed towards optimum utilization.

The following might be noted:

- *Straightness of Tree.*—Seldom is this perfect; many trees develop a lean or a bend at some stage in their growth. Judicous cross-cutting after felling can produce some straight logs from crooked trees. Skilled sawing may produce straight-grained timber from crooked or irregular logs. However, it is difficult to prevent the deviations, due to branches, spiral grain, and interlocked grain, having an effect on sawn products.

- *Branching Habit.*—The eucalypts generally shed their branches at an early age and develop trunks typically free from branches. The pines and other conifers shed very few branches naturally. Every branch attached up to the time of felling and every stub of a branch retained within the bole of the tree will cause a knot to appear in the sawn product. If the branch is alive at the time of conversion the knots can be expected to be sound and tight. If the branch has died long enough before felling for the tree to have laid tissues of the trunk around it, knots wholly or partially encircled with bark, i.e. encased knots, can be expected. The number of branches at one section will affect the incidence of knot clusters. The angle at which the branch emerges out of the trunk will affect the occurrence of spike knots.

- *Persistence of Cones.*—Some pines develop seed cones on the tree trunk and these have been known to remain attached for many years. In this event the stem of the cone becomes embedded in the trunk. If the stem is cut through in the course of sawing it will cause an encased knot to appear in the sawn board. If the cone is knocked off in the course of logging, as often happens, it commonly draws its stem out of the trunk, and, if the resulting cavity is sectioned by the saw, a hole described as a cone hole shows in the sawn product.

• *Stresses in the Trunk.*—It can be demonstrated that internal stresses are present in tree trunks, the intensity varying across a diameter. While the tree is growing the stresses are in equilibrium with counteracting forces. When the balance is disturbed by cutting, a readjustment must take place. Under some conditions this may become evident in the "popping" of the logs at their ends immediately they are cross-cut from the trunk. In other cases the first evidence may be "springing" of the first slabs and pieces subsequently cut from the log longitudinally. The effects reduce the qualities of products recoverable and increase difficulties of producing straight lengths.

• *End Splitting.*—Apart from the effects of the internal stresses, other splitting at the ends of logs or products may develop through fast drying of end surfaces. This is actually a shrinkage phenomenon.

• *Shakes.*—The impact of trees on the ground at time of felling sometimes causes development of falling shakes. A corresponding fault may have been present in the tree prior to felling as the result of damage by storms.

• *Reaction Wood.*—When a tree develops a lean at some stage during its growth, the tree may endeavour to straighten by producing special kinds of tissue. Conifers are found to develop compression wood on the underside of the curve and tend to push the bend out. Hardwoods develop tension wood on the upper side of the curve to pull the bend out. Both forms of reaction wood increase the difficulties of sawing pieces straight, and the products exhibit tendencies towards abnormal longitudinal shrinkage.

• *Gum.*—Some hardwoods, particularly the eucalypts, are liable to exude a gum or kino if they are injured mechanically or by fire. Some insects also stimulate the formation of gum and it is also found at the base of some shoots that sprout out of the trunk after fire. The gum usually spreads over the injured part of the trunk and forms a shield over the growth layer that is injured. Sometimes the gum bleeds through the bark. When trees are felled and cross-cut the gum is frequently visible in rings on the end section. When the logs are sawn or hewn the surfaces that cut through the gum rings show broad splashes of gum on the backcut face and thin lines or veins of gum on the quartercut face. Sometimes intensely localized deposits are seen as gum pockets.

• *Pipe.*—Some trees have defective hearts with or without further deterioration by fungi or termites. Not uncommonly wood around the heart has disintegrated completely at the time of felling, leaving a pipe. Regions surrounding the pipe may be spongy or brittle and are of doubtful value.

• *Fungi.*—Certain types of fungi attack living trees, entry being gained following some form of injury such as fire, mechanical or insect damage to the bark, or the breaking off of a branch. The rate of deterioration in so-called over-mature trees may be equal to or greater than the volume of new wood added.

• *Insect attacks.*—Termites, pinhole borers, shot hole borers and insects of several types attack many trees annually.

• *Fire.*—This is one of the most serious menaces to forests of all ages and types and has at times wrought havoc in magnificent stands. Some species are particularly sensitive to fire and once burnt never recover. Other species can be defoliated by fire but subsequently develop numerous epicormic buds over the trunk and resume growing. The buds, however, spoil the prospect of producing clean timber from the affected trees, and products are marred by gum and knots.

• *Mechanical injury.*—Mechanical damage is not a cause of serious direct damage but the breaking of a limb or the removal of bark may stimulate the production of wound tissues or provide a means of entry for fungi, insects, or other pests, or lead to the formation of the dry side.

In review we can consequently appreciate some of the problems encountered by the sawmiller. Many natural forces act against his interests, causing damage beyond his control and leaving him resources often severely limited in value.

DONATION

THE following donation was received by the Division during April:

S. D. Hillas Pty. Ltd., Melbourne £30 0 0

Klinki Pine—a Substitute for Spruce

By H. KLOOT, Timber Mechanics Section

As willow is to cricket bats, so for many years has spruce been intimately associated with the construction of wooden aircraft. During World War II, a number of local timbers were intensively investigated in Australia as possible substitutes for spruce, and it was shown that, although several species could, if necessary, be used as substitutes, none had all the merits of spruce.

Practically every structural timber of importance in Australia has superior strength properties to spruce and a number of them season, machine, and glue almost as well as spruce. What then is spruce's exceptional quality? When one remembers that in aircraft design weight is as important as strength, it is clear that the proper comparison between timbers to be used for this purpose is between strength/weight ratios, i.e. strengths per unit weight, rather than strengths alone. Three different ratios are of strengths alone. Three different ratios are of importance, namely, strength/density, strength/density$^{3/2}$, and strength/density^2, according to the type of structural element—tension member, beam, or strut—to be designed. Some Australian timbers are as good or even slightly better than spruce on simple strength/density ratios, but it is for beams, and particularly for struts, that spruce is well ahead of its competitors. Put simply, this means that a lighter beam or strut to carry a given load can be designed in spruce than in most other timbers. Hence the aircraft designer's partiality to this timber.

Whilst the days of powered wooden planes are clearly numbered, the interest in motorless aircraft in Australia is rapidly increasing. The glider enthusiast is keen to find a local substitute for spruce because of the latter's high cost and almost impossible supply position. This desire may well be met by the New Guinea timber, klinki pine, which is closely related to the hoop and bunya pines native to Queensland.

The table of properties (below), based on tests conducted by the Division of Forest Products on dry material from 20 trees of klinki pine, shows the marked similarity with the properties of spruce.

Property	Klinki Pine	Sitka Spruce
Moisture content (%)	12·0	12·0
Density (lb/cu. ft.)	28	28
Modulus of rupture (lb/sq. in.)	11,100	10,200
Modulus of elasticity (lb/sq. in.)	1,730,000	1,570,000
Maximum compression strength parallel to grain (lb/sq. in.)	6,370	5,610
Bearing strength perpendicular to grain (lb/sq. in.)	636	710
Maximum shear strength (lb/sq. in.)	1,390	1,150
Hardness (lb)	540	510
Toughness (in. lb.)	72	82

As may be seen from the table, with the exception of bearing strength and toughness, klinki pine is, if anything, slightly superior to spruce. Because the densities are similar, klinki pine is at least the equal of spruce for each of the strength/weight ratios important to the aircraft designer. Besides having similar mechanical properties, klinki pine is just as easy to work and glue as spruce, and so should be a very satisfactory substitute.

Although the imports from New Guinea are as yet at a relatively low level (3 to 4 million super ft of sawn timber in 1956), there is every reason to believe that these will increase. The requirements of glider builders are, however, quite small, so their needs should be easily met even at the present time.

As in all softwoods, klinki pine is subject to the abnormality known as "compression wood", which shows up as dull yellow or brownish coloured bands along the grain. The presence of compression wood with its abnormal shrinkage characteristics tends to make the timber refractory in its seasoning behaviour. However, if reasonable care is taken in the selection, it seems that a most satisfactory substitute for spruce has at last been found in klinki pine, and in this part of the world it could, in a short time, well oust spruce completely from aircraft structures.

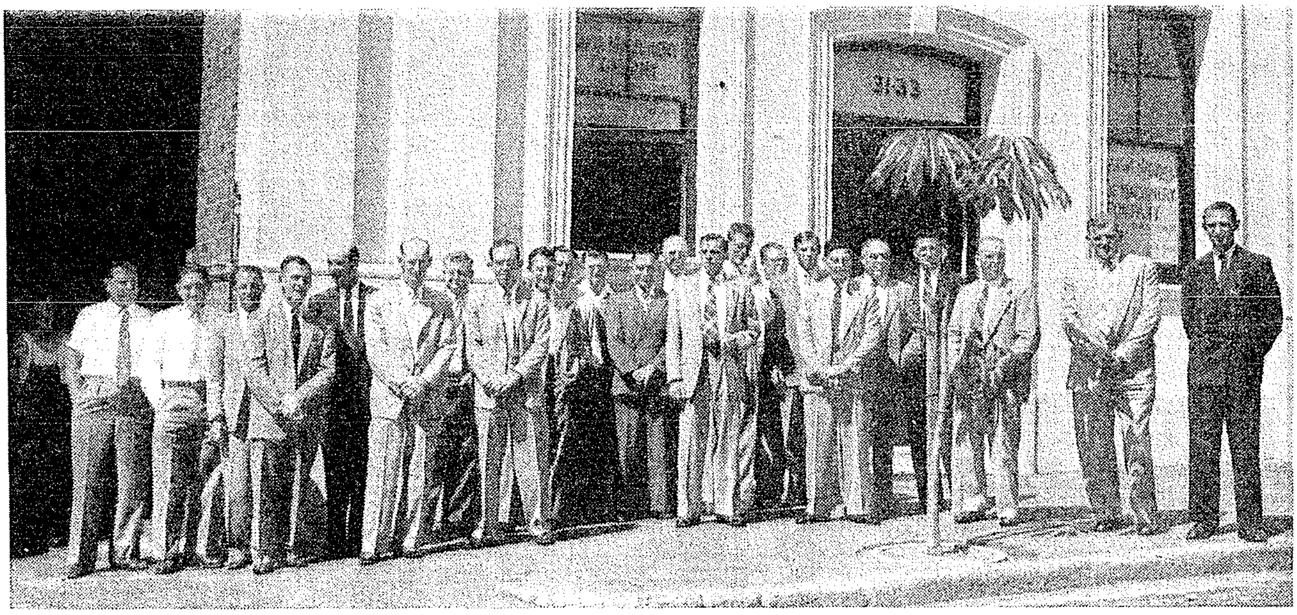
A description of the properties and general uses of klinki pine and a discussion of the seasoning of this timber were given in Newsletter No. 214 (January 1956). Copies are available on request to the Chief, Division of Forest Products, C.S.I.R.O., 69–77 Yarra Bank Road, South Melbourne.

Brisbane Timber Seasoning Course

OFFICERS OF THE DIVISION held another successful 5-day Seasoning Course in the Oddfellow's Hall, Brisbane, through the week April 1–5 inclusive. The course was given at the joint request of the Queensland Sawmillers' Association and the Queensland Timber Stabilization Board, for the benefit of member firms. Lecturers were Messrs. G. W. Wright (Officer-in-Charge, Timber Seasoning Section of the Division) and G. S. Campbell (Senior Technical Officer).

Over 30 representatives of the following 24 firms participated: S. Adams; Brandon Timbers Ltd.; Brown & Broad Ltd.; James Campbell & Sons (Pty.) Ltd.; Cooroy Sawmilling Co.; Corbett Bros.; East Coast Timbers Pty. Ltd.; W. B. Fairlie; Hamilton Sawmills Ltd.; Hancock & Gore Ltd.; Hancock Bros. Ltd.; Howard & Sons; Hyne & Sons; Kruger & Sons; Pattersons Pty. Ltd.; Queensland Builders Service; Queensland Timbers Pty. Ltd.; Simon Pty. Ltd.; Straker & Sons; Weatherhead & Co.; Western Timbers; Wilson Hart & Co.; J. Wilkinson & Son, and Woodland Woodworks.

The course comprised 15 lectures on stacking, handling, and drying sawn timber and veneer; plant lay-out; the design and operation of modern seasoning kilns and driers; and the economics of kiln operation. Included also were a course of practical work, discussions on drying problems, and visits to modern seasoning plants. The plant visits were a most effective part of the course: for their success the instructors and class members are indebted to the managements and staffs of Messrs. Brandon Timbers Ltd., Brown & Broad Ltd., and Hancock & Gore Ltd.



Group attending Brisbane Timber Seasoning Course, April 1957.

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Can the Strength of Radiata Pine be Improved?

By H. KLOOT, Timber Mechanics Section

THE general characteristics of radiata pine are fairly well known in the timber trade. With many people, there is an impression that it is only a second-rate substitute for the more commonly used timbers in structures, but this impression is based on experience with timber cut from relatively young trees of small diameter. Recent investigations by the Division have shown that the story can be quite different with older trees of radiata pine.

Figures 1 and 2 illustrate the average strength variation of defect-free wood through 40-year-old trees of South Australian grown pine. As may be seen from the curves, in the early years when the tree is small in diameter, the strength of the timber is certainly low compared with other well-known timbers. However, there is a marked increase in strength with age and diameter, an increase which is not shown to anything like the same extent in virgin growth timbers. This increase is so great that, by the time the tree reaches 15 years of age, the strength of its wood in the air-dry condition exceeds the average strength of Douglas fir and mountain ash, as indicated on the Figures. In fact, bending strengths of individual specimens have been recorded as high as 23,000 lb/sq. in. The pattern for compression strength is similar: test values include many over 10,000 lb/sq. in. and several as high as 12,000 lb/sq. in. have been recorded.

A further point of interest is the density of this high strength material. In the following table, the average bending strength of radiata pine laid down in the age period 20–40 years is tabulated with the average density of the wood for the same period. In addition, the species average properties for several other well-known timbers are listed.

Strength/Density Ratios

For defect-free air-dry timber

Timber	Average Modulus of Rupture (lb/sq. in.)	Average Air-dry Density (lb/cu. ft)	Strength/Density Ratio
Radiata pine*	17,600	40	441
Douglas fir	11,700	34	344
Mountain ash	16,000	42½	377
Messmate stringy-bark	17,100	49	349
Blackbutt	21,200	55	386
Spotted gum	20,000	63½	315
Karri	19,700	53½	355
Grey ironbark	27,100	69½	390

* Last 20 years of 40-year-old trees.

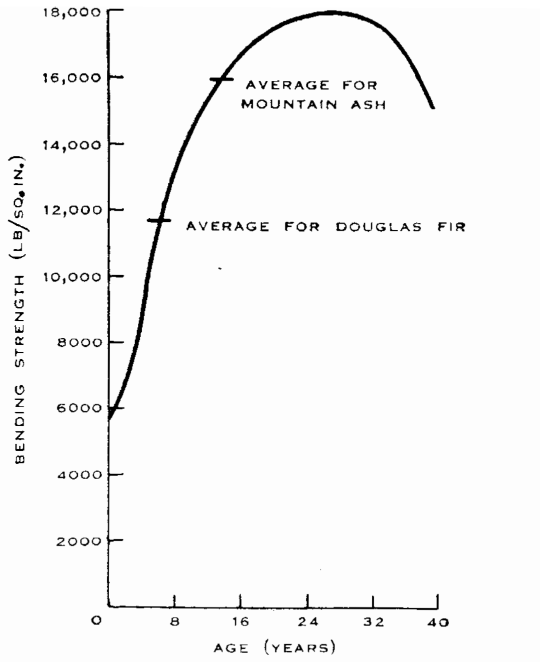


Fig. 1.—Variation of bending strength of defect-free dry radiata pine with age.

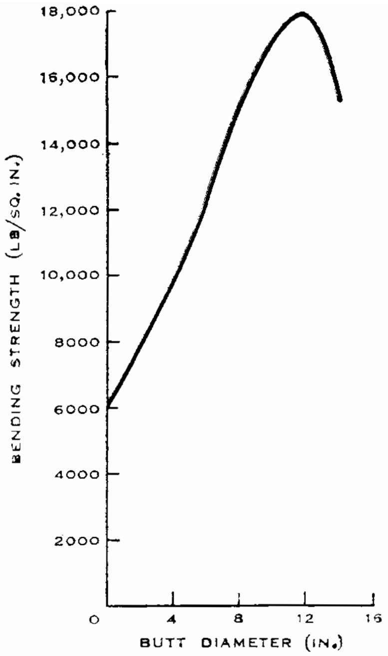


Fig. 2.—Variation of bending strength of defect-free dry radiata pine with butt diameter.

It is immediately apparent from the strength/density ratios that the timber grown in the last 20 years of a 40-year-old radiata pine is much superior to any of the other timbers listed. In fact it is superior, weight for weight, to practically every other important species in Australia.

Brief though it is, this picture of the strength and density of radiata pine certainly throws quite a different light on this species from the one based on past experience and shows that potentially at least, radiata pine is a first-rate structural timber.

At this stage, however, certain reservations have to be made. First of all, the property values mentioned here were determined on defect-free specimens, that is, free of all knots and cross-grain. To get timber of anything like this quality will require high pruning of the trees and this, at the moment, is carried out to only a very limited extent.

Secondly, radiata pine grown in other regions under differing soil and climatic conditions may not yield timber with such high properties. There is evidence to show that radiata pine grown on a site of much higher quality than is available in South Australia increases very rapidly in girth but does not show the marked increase in strength with age. This may present quite a problem later if some advantage is to be taken of the high strength of the timber grown in certain areas.

Thirdly, there is the difficulty in conversion. To capitalize on the higher strength values, the material from the strong outer shell of the tree has to be effectively separated from the relatively weaker inner core. Where pruning is practised segregation will be easy because virtually all the clear material beyond the overgrown branch stubs will be high strength quality. Finally, there is the suggestion, as can be seen in the Figures, of a tendency for the properties to fall off over the last 5–10 years of the life of a 40-year-old tree. The reason for this is not known. It may be the natural tendency in this species but it is considered more likely that suitable silvicultural treatment would correct this tendency.

The overall picture would therefore appear to be that, given careful control of its growing conditions and of its conversion when felled, the radiata pine tree is capable of producing a timber of high strength/density ratio for structural purposes which is difficult to match in Australia.

LIGNOTUBERS

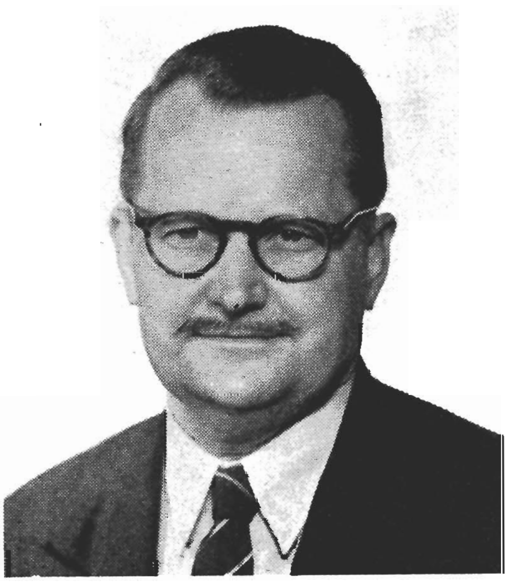
By M. MARGARET CHATTAWAY, Wood Structure Section

ALMOST EVERYONE is familiar with *lignotubers* in their most extreme form of development, as mallee roots burning on a fire or stacked in the wood heap against the onset of winter, but not everyone is aware that this is only the end form of a series of swellings that occur at the base of the main stems of the majority of eucalypts and vary in different species from the size of a pea to a considerable lump of hard woody tissue. In the majority of species the lignotubers are overtaken by the normal growth of the stem and are no longer visible by the time the tree has reached pole stage; in some they are easily overlooked unless very young material is examined.

The question of lignotubers is quite important from a practical angle, as they are one of the main regenerative regions of the species in which they occur.

Lignotubers are woody masses of storage tissue; fibres, tracheids, and parenchyma cells are all packed full of starch, and the ray cells also contain protein. Concealed and dormant buds occur, often in considerable numbers, and, like the "eyes" on a potato they grow out into new shoots when the need occurs. Though most species of *Eucalyptus* have lignotubers, there are some, and among them are important commercial timbers such as mountain ash, karri, and alpine ash, in which they do not develop.

Our knowledge of the structure of lignotubers rests mainly on the work of Kerr and Carter who described them and listed the species in which they were known to occur. Although both these authors described mature lignotubers and noted their occurrence in the nodes of the cotyledons and in the lowermost nodes of the stem, neither of them pursued the matter further to see whether there was any difference between the cotyledonary and leaf nodes or between the nodes of species which do and those which do not have lignotubers. These questions are really fundamental to the whole problem. Recent work in this Division has attempted to pursue just those points and to find out whether there is any structural difference between the cotyledonary nodes of species with lignotubers and those without.



MR. R. F. TURNBULL, Officer-in-Charge, Utilization Section, proceeded overseas early in June to investigate modern developments in wood conversion and timber utilization. In South Africa and Hawaii he will look particularly into the techniques for conversion of young plantation eucalypt hardwoods, and in Europe at procedures used in sawing small and low-quality logs, and developments in the utilization of sawmill residues. Mr. Turnbull's programme in the United States includes a survey of the mechanization of small- and medium-sized sawmills and the status of research on sawing. Mr. Turnbull will also spend a short time in New Zealand studying the integration of wood-using industries.

Let's Discuss Sawing

with ***D. S. JONES, Utilization Section***

Teeth for Automatic Docking Saws

Automatic docking saws usually work under very severe conditions, being forced rapidly into thick pieces regardless of whether or not they are capable of making a heavy cut at that instant. Furthermore, the blade has no lateral support. Consequently these saws need frequent attention and often give considerable trouble. Mr. John Nicholes, the saw doctor at Saxton Timber and Trading Ltd., Licola, Vic., was not satisfied with the performance of the modified ripsaws being used in the mill's automatic pendulum docker. As often as a dozen times a day the machine would jam in the middle of a cut, and someone from another part of the mill would have to leave his job to free it. Mr. Nicholes's treatment of the problem is of general interest, and his permission has been obtained to pass on the details of his work.

The first trial saw was unconventional, the design being based on the bold assumption that if the teeth of automatic dockers were to grab, and cut just as fast as they grabbed, jamming would be eliminated. This meant that a large positive hook angle was required. Accordingly a 36-in. diameter, 54-tooth saw was prepared, the teeth having a hook of about 40° ($\frac{5}{6}$ radius or 15 teeth on a 54-tooth saw), a front bevel of about 8°, and a top bevel of about 15°. The tooth set was 30 thou. (0·030 in.). This saw performed very well indeed, it made remarkably little noise, and jamming in the cut was entirely eliminated.

The second trial saw was a reversion to a conventional peg-type cross-cut of the same diameter and with the same number of teeth as the first saw. The teeth were $1\frac{1}{4}$ in. deep and had a negative hook of 18° ($\frac{1}{3}$ radius or 22 teeth on a 54-tooth saw) and a back angle of 26° ($\frac{1}{2}$ radius or 19 teeth). They were bevelled front and back and the set was 35 thou. This saw made more noise than the saw with positive hook, it occasionally jammed in the cut, and required sharpening earlier. However, it had the advantage of being much easier to prepare, because with the positive hook extreme care was necessary, when the teeth were stripped, sharpened, and set, to prevent excessive and dangerous grabbing. It was considered that the ease of preparation of the peg-tooth saw gave it an advantage over the positive hook saw, even allowing for its inferior behaviour.

Subsequent experiment has shown that back bevel is unnecessary and that a front bevel of 5–10° is adequate. Rather than file both front and back bevel and turn the saw round when one side is worn, Mr. Nicholes prefers to file the saws more often and maintain only one bevel. These saws now rarely jam in the cut, and they are sawing approximately 40 tons of foot blocks per sharpening. The machine has a stroke of 41 in. and operates at 40 strokes per minute. It is driven from a 30 h.p. motor which simultaneously drives a hand-operated pendulum docker.

DONATIONS

THE following donations were received by the Division during May:

A. J. van Boxsel	£2 2 0
Monsanto Chemicals (Aust.) Ltd.	£100 0 0
Kirkpatricks Pty. Ltd.	£5 5 0
J. R. Hall (Machinery) Pty. Ltd. (8-in. "Wigo" saw, carbide-tipped teeth and inserted teeth for display purposes)	£12 0 0
Supercut Saw & Knife Co. Pty. Ltd. (18-in. circular saw with various shaped teeth for display purposes)	£12 10 0

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Forest Products Newsletter

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1957##233

NUMBER 233 MELBOURNE AUGUST 1957

Fence Post Treatment on King Island

By F. A. DALE, Preservation Section

KING ISLAND, in Bass Strait, has no naturally durable timbers suitable for fence posts. The Land Settlement Division of the Agricultural Bank of Tasmania has an extensive settlement programme under way on the island, requiring many thousands of fence posts, but lack of a suitable harbour limits shipping to small vessels, with the result that split messmate and peppermint fence posts from Tasmania at present fetch about £32 per 100 landed on the island.

In October 1956, officers of the Bank visited the Division of Forest Products to discuss the preservative treatment of round fence posts which could be cut in quantity on the island from manna gum (*Eucalyptus viminalis*), tea-tree (*Melaleuca* spp.) and plantation-grown *Pinus radiata*. After inspection of the possibilities on the island a proposal was submitted for a semi-portable treatment plant using a water-borne preservative at a pressure of 50 lb/sq. in. This pressure is higher than that recommended previously because of the need for faster treatment, while still obtaining full sapwood penetration. A highly fixed preservative of the copper–chrome–arsenic type was chosen because of the high cost of creosote on the island and the cleanliness and ease of handling of a water-borne salt.

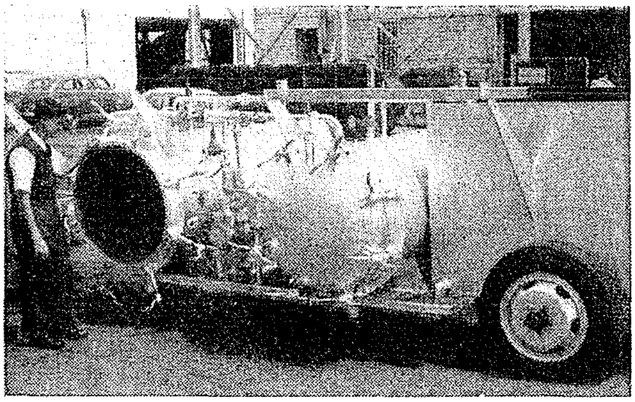
After the proposal had been approved, a sketch plan was submitted to a Melbourne boilermaker who built the plant and tested it in a little over two months. The plant consists of two identical treating cylinders, an engine-driven pump, and a storage tank, all mounted on a low-loading platform trailer. The trailer (supplied by another firm) is only intended to carry the plant on the road when empty, movement when full being restricted to short moves at the treatment site. The twin cylinder arrangement was chosen in preference to one long cylinder because the latter would need bogies and track to handle the posts. As the two cylinders can be loaded and unloaded in rotation there is little time or effort wasted with this arrangement.

The plant is illustrated on page 2 and the pipe circuit on page 3. Each cylinder is 7 ft 6 in. long by 3 ft 1 in. diameter, of 3/16 in. steel plate with $\frac{1}{4}$ in. dished ends and doors. The doors are secured by eight $1\frac{1}{4}$ in. screw dogs and seal on a rubber strip as in the Division's own portable plant, described in Newsletter No. 200.

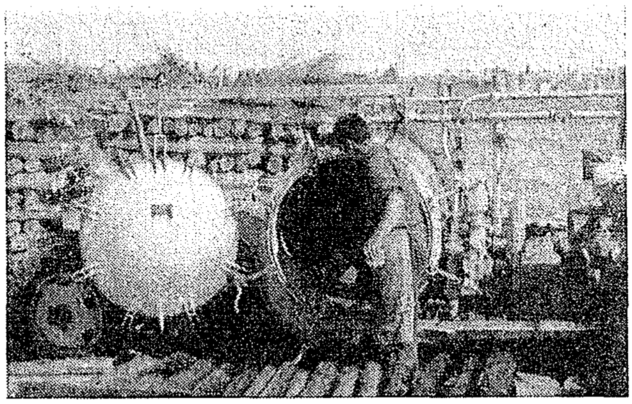
Forty to fifty posts of 3 in. to 5 in. top diameter by 6 ft long will go in each cylinder, the extra length being for strainers and gate posts.

The open storage tank holding 550 gallons is made of $\frac{1}{8}$ in. plate stiffened with an angle around the top edge.

The double-acting piston pump was chosen for simplicity and reliability. It is driven by a low-speed 2 h.p. water-cooled petrol/kerosene engine and can deliver about 850 gallons/hr at pressures up to 100 lb/sq. in.



Plant before shipment.



Plant in operation.

It can draw from or deliver to either cylinder or the storage tank, and points are fitted for suction and delivery hoses as well. A relief valve in the delivery prevents overloading and each cylinder has its own safety valve.

A "low-down" hand pump is mounted on the trailer for transferring solution from a 200 gallon mixing tank to the storage, and for emergency use.

The cost of the plant ex works was about £800 and that of the trailer £450.

Plant operation started in April, using gum and tea-tree posts which had been cut for some months but not adequately stripped out in the drying stacks. For this reason the posts were not dried to the desired 25 to 30 per cent. moisture content in the sapwood. In spite of this they treated readily with a 6 per cent. solution of preservative, full penetration of the sapwood being obtained.

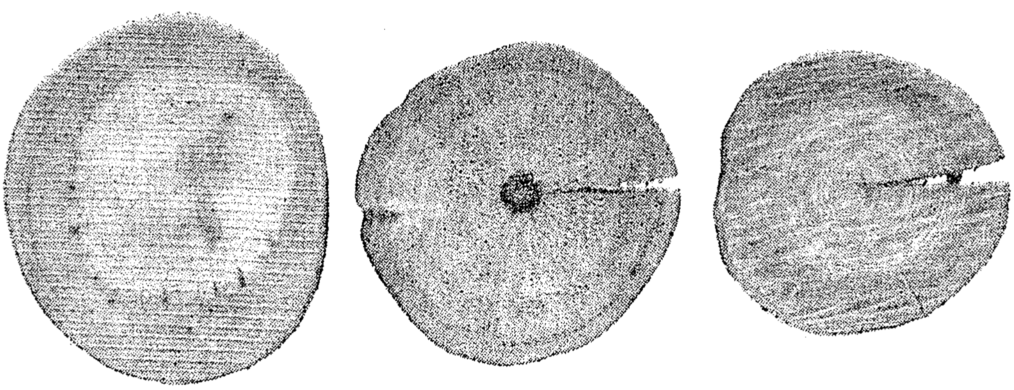
Some cross sections of typical treated posts are illustrated below.

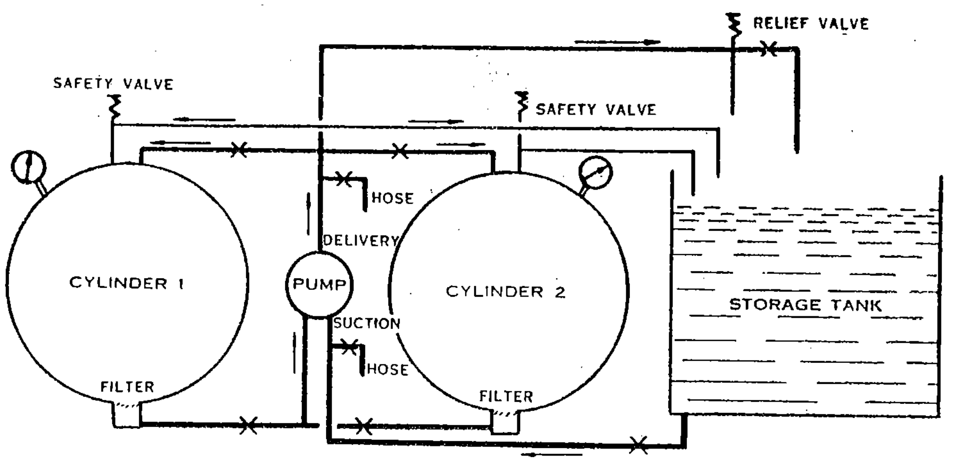
Since April the plant has treated over 10,000 gum and tea-tree posts 3 in. to 5 in. in diameter and 6 ft long at an average rate of 300 posts per day. Three men work the plant; they also dock the posts to length with a tractor-driven saw before treatment. The plant is set between two rows of drying stacks and is moved along the rows by tractor every day or so as each stack is treated.

The average treating cycle is just over 2 hr and usually four charges are treated in each cylinder each day. The last charges are left under pressure when work ceases, and the pump is turned off later, leaving the charges to be unloaded next morning. On several occasions five double charges were treated in a day and with practice this could become normal routine, particularly if the plant were modified to enable pressure to be maintained in one cylinder while the other was being filled. As a cylinder full of posts takes 15 min to fill with solution this would save 1 hr each day.

In the first 15 working days 4585 posts were treated, using 1555 lb of salt. The posts averaged 4 in. in diameter and gave a loading of about 0.55 lb of dry salt per cubic foot of total volume. On average posts with 1 in. of sapwood this represents about 0.8 lb dry salt per cubic foot of sapwood. The cost of preservative was less than 1*s.* per post (£5 per 100).

Treated post sections (left to right): E. viminalis, P. radiata, Melaleuca *sp.*





SCHEMATIC LAYOUT OF PLANT

Although the costs of felling, barking, and drying the posts and the establishment costs of the plant have yet to be assessed, it is expected that a saving of at least £10 per 100 posts will be realized compared with imported posts. The Tasmanian posts could not be expected to last more than 15 to 20 years, but the treated posts should give 25 to 30 years service. They are also lighter, easier to handle, and can be driven by hand or with a power-operated post driver, except in very dry or rocky ground. Staples will probably be used to fasten wire to the posts, but a multiple drilling machine used in conjunction with the docking saw could make pre-boring a very cheap operation if it were needed.

As all the dry tea-tree and gum posts have now been treated, the plant is being moved to the island's pine plantation, where 3500 thinnings have been killed with arsenic in a chemical de-barking trial. These trees will yield about 17,500 posts and preliminary tests indicate that they are now dry enough to treat although still standing. They should appreciably reduce the overall cost of treatment.

The Land Settlement Division has given a lead to the rest of Australia by this project, which is the first large mobile post treatment plant to operate in the Commonwealth. Thanks to their enthusiasm and that of the manufacturers the plant was operating within six months of its conception.

Since the publication of C.S.I.R.O. Leaflet No. 12 "Round Fence Posts: Preservative Oil Treatment" there has been growing interest in fence post treatment. A fixed low-pressure creosoting plant has been in operation near Melbourne for some time and will be described in a future Newsletter. Low-pressure plants are being planned for Western Australia, South Australia, Victoria, and New South Wales as distinct from the orthodox 200 lb/sq. in. pole treatment plants now operating or under construction.

DONATIONS

THE following donations were received by the Division during June:

Philip Morris (Aust.) Ltd., Moorabbin	£2	2	0
Queensland Sawmillers' Assn., Brisbane	£70	0	0
Ezard and Sons, Swift's Creek, Vic.	£100	0	0
I.C.I.A.N.Z. Ltd., Melbourne	£100	0	0
James Timber Co. Pty. Ltd., N.S.W.	£25	0	0
Queensland Timber Stabilization Board, Brisbane	£200	0	0
Walker Bros., Gosford, N.S.W.	£10	0	0
A. A. Swallow Pty. Ltd., Melbourne	£100	0	0
Fagg Bros. Pty. Ltd., Geelong	£25	0	0

Flindersia pubescens (*silver ash*).
Girth 8 ft, first limb 65 ft.

PROPERTIES OF AUSTRALIAN TIMBERS

Silver Ash

SILVER ASH is the standard trade common name given to the timbers of three species of the genus *Flindersia*. They are *F. bourjotiana* (Queensland silver ash), *F. pubescens* (northern silver ash), and *F. schottiana* (southern silver ash), also known as bumpy ash and cudgerie.

Habit and Distribution

The trees of these species attain average heights of 100 ft with a girth of about 9 ft, *F. bourjotiana* reaching 120 ft on occasions and the taller *F. pubescens* and *F. schottiana* sometimes reaching 150 ft. In general they are of good form, with a long clear bole which in *F. schottiana* is somewhat marred by protuberances at intervals—hence the name bumpy ash. Southern silver ash occurs in the coastal scrubs as far south as the Hastings River in New South Wales. The other two species occur principally on the tablelands of north-eastern Queensland.

Timber

The heartwood varies from yellowish white to a pale brown. The grain is usually straight but may be interlocked. There is very little figure except around the characteristic bumps of the southern variety, and a wavy fiddleback which sometimes occurs in northern silver ash. The timber is similar to mountain ash (*Eucalyptus regnans*) in strength, density, and durability. At 12 per cent. m.c. it weighs from 35 to 52 lb/cu. ft, averaging 43 lb/cu. ft. *F. bourjotiana* is the lightest, with an average of 39 lb/cu. ft compared with 44–45 lb/cu. ft for the others. The timber falls into durability class 3 and strength groups C and D. The sapwood is susceptible to *Lyctus* borer attack.

Silver ash is easily worked with hand or machine tools, peels and slices well, glues easily, and makes high grade plywood. It is easily finished in natural colour but filling and staining are sometimes difficult. It bends well but several laminations are generally preferred to solid timber for sharp bends.

Seasoning

The timber is fairly slow-drying and reasonable care is needed to air-dry or kiln-dry it free of degrade. Partial air drying prior to kiln drying is recommended to prevent collapse. Reconditioning is not recommended as it causes face-checking. Queensland silver ash dries faster than the other varieties. In drying from green to 12 per cent. m.c., moderate shrinkage of 3·5 per cent. in the radial direction and 5·5 per cent. in the tangential direction can be expected.

Uses

Silver ash has a very wide range of applications. Light construction, veneer, plywood, tool handles, boat and carriage framing, turnery, sporting goods, furniture, and interior finishing are its main uses but there are many other special uses.

Availability

It is estimated that approximately 4·5 million super ft (Hoppus) is available each year for milling into boards, planks, and scantling. Veneer and plywood are also produced in quantity.

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Ripping Logs with Power Chain Saws

By W. M. McKENZIE, Utilization Section

THE POWER CHAIN SAW was primarily designed as a portable cross-cutting machine, and its cutting action in ripping is less efficient than that of other ripping saws. Nevertheless the facts that the chain saw is portable and can have a very long cutter bar make its use for ripping worth while in certain situations:

- Among logs from virgin forests there may occasionally be a butt log too big in diameter for a sawmill's breakdown rig. If such a log, often containing very good timber, is to be used, other means must be used to break it down.
- In over-mature forests there may be large trees with a high proportion of defect such as rot and pipe, but yet with much valuable wood in them. To avoid transporting the defective wood, it is necessary to eliminate this at the stump, producing sound wood in the form of billets.

The explosive splitting gun is frequently used in both situations, but it may be defeated by interlocked grain, it may split a log crookedly and waste some of the wood, and it may be dangerous. Use of the power chain saw avoids these disadvantages.

It was not until the gouge-type chain was developed that ripping with chain saws became common. The scratch chain is designed for cross-cutting, and has teeth for severing fibres and other teeth for shearing the severed fibres away. When the functions of the teeth are reversed they do not act efficiently. The results are high power consumption, overheating, rapid wear, and a tendency for the teeth to follow the grain, causing the chain to wander. Nevertheless some European ripping equipment uses the scratch-type chain. The gouge-type chain, with a tooth that has an edge suitable for severing fibres across the bottom of the kerf, is much more successful. It requires less power, keeps cooler, wears longer, and cuts straighter than the scratch-type chain. The efficiency of a chain in a ripping cut is increased if the motor end leads the tailstock end, so that the teeth bite readily and take a thick chip without great pressure on the saw. With the tailstock leading the motor or the cutter bar square, the teeth are led out of the wood,

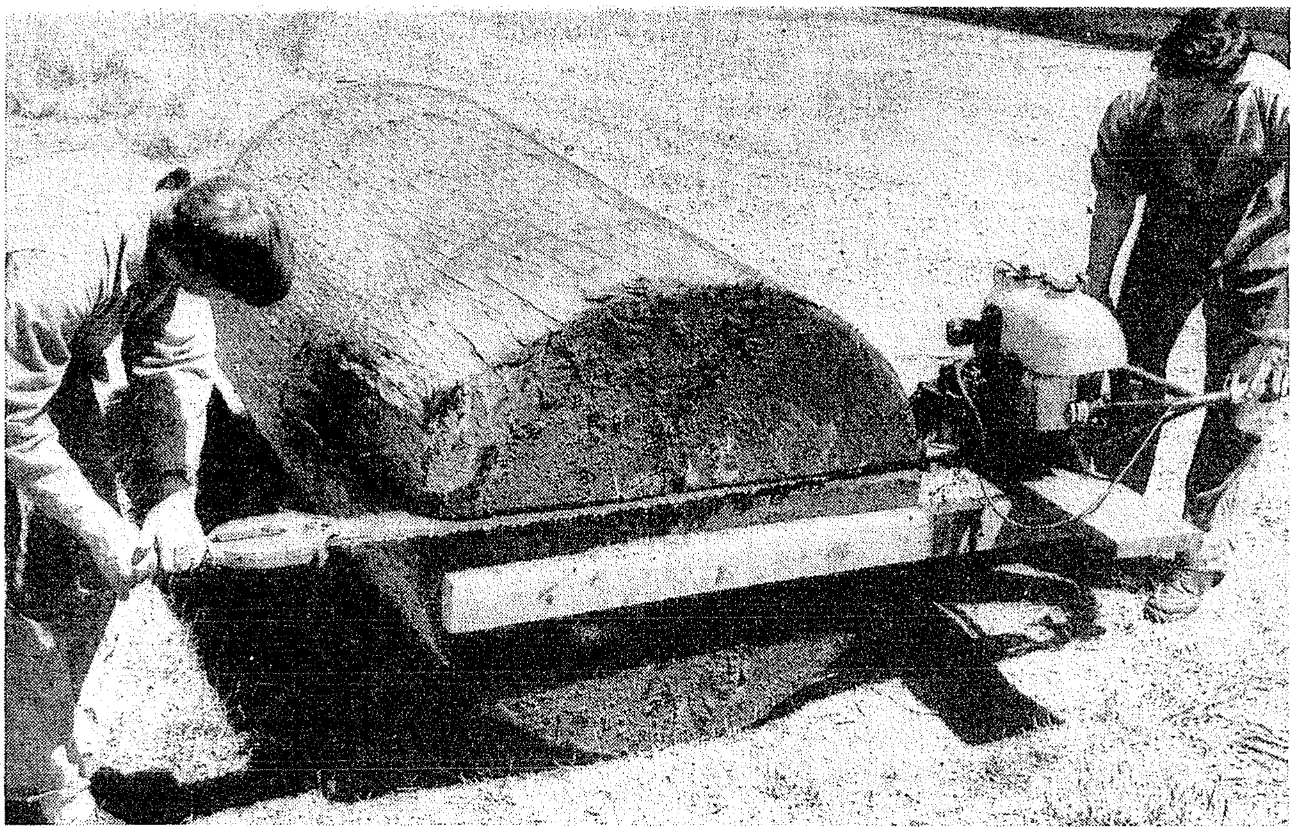


Fig. 1.—Ripping with a chain saw, using planks to support and guide the saw.

and considerable effort is required to make the teeth bite instead of rubbing. More power is required with the motor leading, but a saw which has insufficient power to operate this way is too light for the work.

Blunting is more rapid when ripping than when cross-cutting. In ripping softwood, a gouge-type chain must be sharpened after sawing 100–120 sq. ft, so that a sharpening life of 60–80 sq. ft may be expected in ripping moderately dense non-abrasive woods such as the eucalypts. It is preferable to file frequently rather than allow the chain to become very blunt. The sharpening life may be extended by hard chromium plating of the teeth, which is being practised to an increasing extent.

More power is required for ripping than cross-cutting, and also the cutting time is much longer, so that the saw motor must be able to sustain a heavy load for periods up to 30 min or more. Chain saw petrol motors are designed to run at full power only for periods up to a few minutes, so that it is desirable to use a machine more powerful than would be necessary to cross-cut a given log, especially if ripping is frequent. Electric motors are better for sustained loads, and since there are means of relieving the weight, these motors should be used where possible. Considering the density of many Australian timbers and the size of logs involved, trouble-free ripping would not be expected with a chain saw motor of less than 10 h.p.

Another requirement for successful ripping of logs is a means of ensuring a reasonably accurate cut. This is necessary to avoid waste in subsequently correcting a crooked cut. In addition, the operators must be relieved of the weight of the saw because fatigue, which affects accuracy, sets in rapidly. The various rigs described below are designed to ensure accuracy and relieve weight.

The simplest and most flexible arrangement is to use a chain saw that is used mainly for cross-cutting, but which has adequate power for ripping and incorporates a cutter bar that can be swivelled for horizontal cutting. To prepare for ripping, planks are spiked to the ends of the log with their top edges horizontal and at such a height that the saw will cut where required. One end of each plank projects, and carries another long plank, which may be supported by spikes at intermediate points along the log to keep it straight. This carries the motor end of the chain saw. By reference to the end planks, a line is chalked on the opposite side of the log to guide the man supporting the tailstock end of the saw (see Fig. 1). Probably the ideal saw for this kind of operation, and one frequently used in America, is driven by a 10-h.p. 180-cycle electric motor. This is light compared with the conventional 50-cycle motor, and does not have the vibration or fumes of a petrol-driven motor. In California large hollow redwood logs have been ripped by using a chain saw with no tailstock, the operator standing on top. The log is ripped to the centre, then turned over, and the operation repeated. However, the circumstances favouring this technique will rarely be found elsewhere. With the abovementioned saw and using the plank method, the sawing rates in American softwoods such as Douglas fir have reached 5 sq. ft/min, and in redwood, 10 sq. ft/min. With the same rig, a sawing rate of 3–4 sq. ft/min might be reached in ash-type eucalypts.

The next stage in elaboration is more typical of Europe, and enables high-powered heavy chain saws to be used (see Fig. 2). Manufacturers supply a steel staging, which may be dismantled and set up over a log. The chassis, which can be levelled up and adjusted for height by screws at each of the legs, supports a movable carriage with a bow to clear the log. The carriage supports both saw motor and tailstock. The carriage is propelled by a hand winch at one end of the chassis, or may even be motorized. The equipment has the advantage that a very heavy or powerful saw may be used without fatigue, the sawing may be controlled by one person at a distance from the saw (avoiding fumes and sawdust), the saw is precisely guided, and reasonably accurate flitches may be sawn by simply lowering the chassis. On the other hand the cost is high, and if this is to be borne economically the machine must be used frequently. Also, shifting from log to log is slow, although this disadvantage is being reduced by lighter construction.

The most elaborate equipment for ripping logs with chain saws has been developed in America for more or less regular breaking-down of large logs in the pond. A heavy-duty cutter bar and chain, driven by electric motors of up to 30 h.p., is mounted on a deck or on a float, and the floating logs drawn through. There are also a few land-based rigs with a carriage to carry the log through the chain saw, which is mounted vertically, but pond sawing is considered more successful. The cutting rate for such equipment may be as high as 20 sq. ft/min in softwood. This type of rig serves the same purpose as the frame saw, often used for big logs in Australia. It would probably be more expensive to install and maintain, but would have a greater output. In any case, at the stage where a machine is required for regular breakdown of big logs at the sawmill, the use of a chain saw is unlikely to be the most economical solution because its cutting action is less efficient than that of conventional ripping saws, owing to higher power consumption and greater saw maintenance.

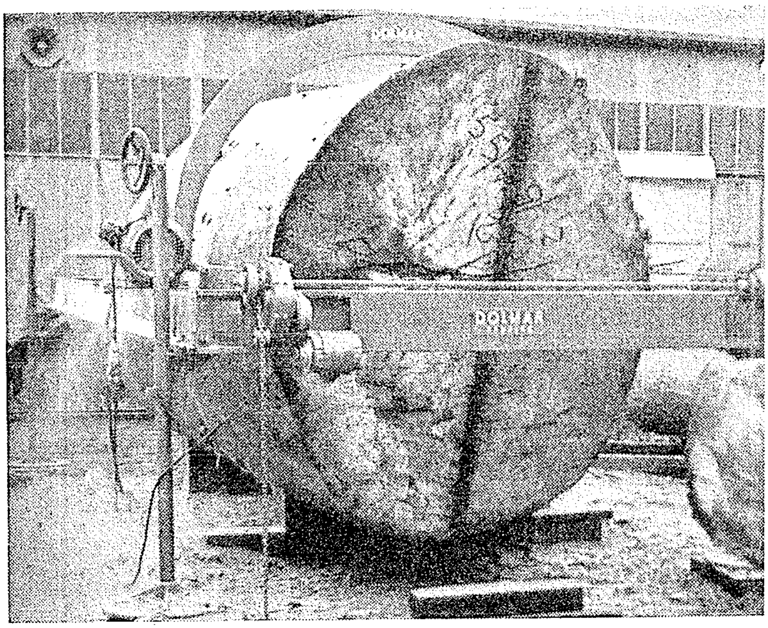


Fig. 2.—German chain saw log-ripping equipment.

Eradicating Termites (White Ants) from Buildings—Part I

By J. BEESLEY, Wood Preservation Section

These notes deal only with the eradication of soil-dwelling (subterranean) termite attack in completed houses and do not take into consideration structural alterations which can be made in new buildings to prevent termite attack.

WHITE ANTS, or termites as they are more properly called, attack growing timber and dead trees, logs and stumps, poles and posts, and buildings and other constructional timbers. They are amongst the most destructive of all the insects which attack wood and will either seriously weaken or destroy any timber they feed upon. Hence, termite attack should never be neglected.

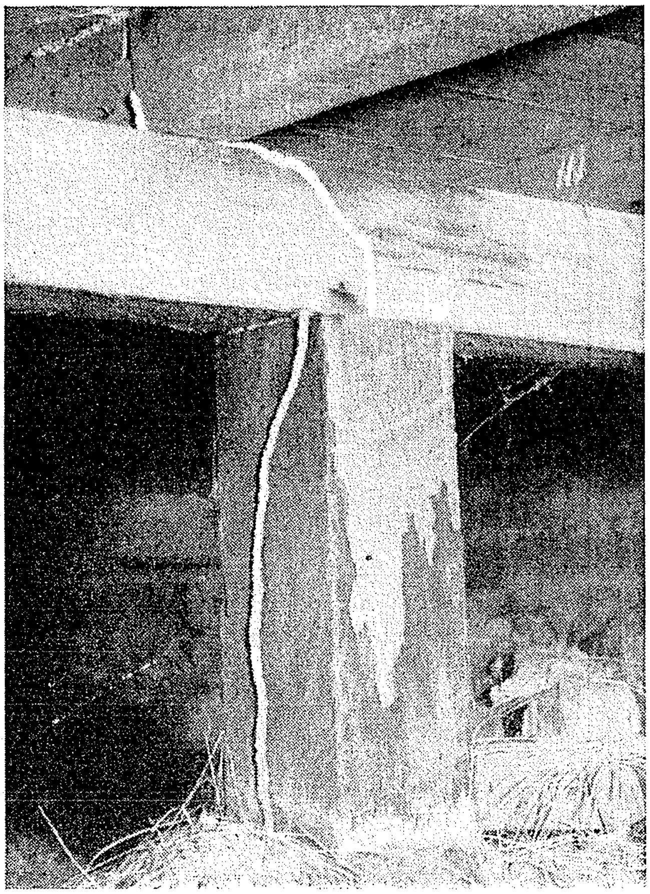
About 200 species of termites are known to occur in Australia. All are social insects which live in well-organized colonies. Some are forest insects which attack green and growing timber. Others, which are found only in the more tropical parts of Australia, thrive in dry seasoned wood and require no contact with the soil. Intermediate between these two groups are about half a dozen species, known as the subterranean or soil-dwelling termites, which feed upon dry wood, but which obtain their moisture from contact with the soil. These few species are responsible for the greater part of the damage of economic importance caused by termites to timber in service in the tropical parts of Australia and all the termite damage of economic importance in the remainder of the country.

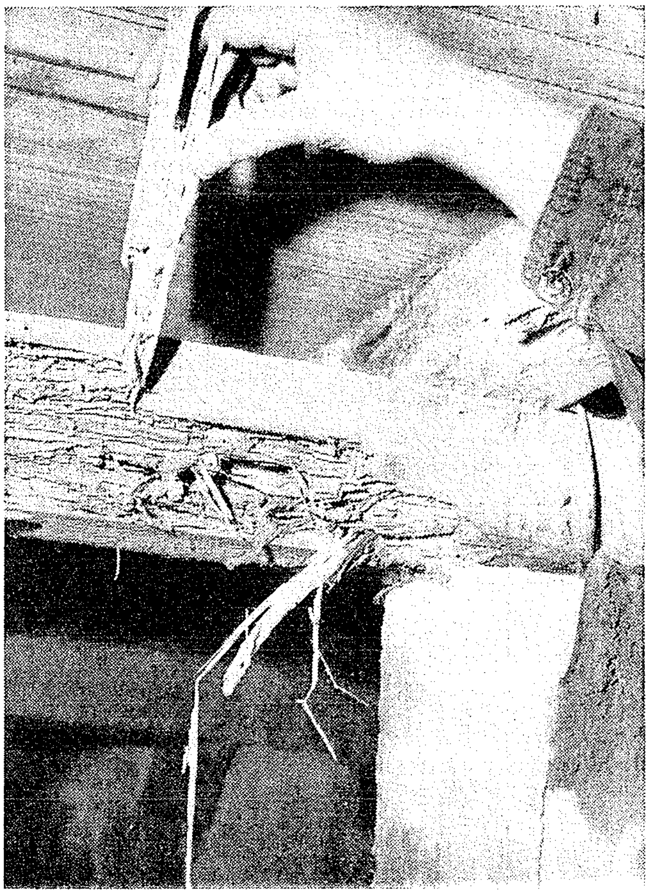
Soil-dwelling termites may nest in any large piece of timber in direct contact with the soil, such as a post or power pole, a stump or log, or the hollow butt of a living tree. The nest may be entirely underground or may take the form of a mound large enough to fill a wheelbarrow.

All soil-dwelling termites have similar habits. The colony is founded by a pair of "flying ants" (alates, or winged reproductives) which leave the parent nest during stormy weather in spring and early summer and which become the king and queen of the new colony. Starting with a single pair, a new colony may take years to reach maturity, when its population may number well over a million individuals with a reproductive capacity of several thousand in every 24 hr. A few species are also able to form new colonies by a system of "budding-off" from the parent nest. These daughter-colonies can function independently of the parent colony.

All attack by soil-dwelling termites originates from the nest and all the individuals of the colony periodically return to it. They usually obtain their food by tunnelling through the soil to susceptible timber buried in the soil or resting upon it. In order to reach susceptible timber above ground they may channel through timbers they do not normally attack, or construct mud-covered shelter-tubes over materials they cannot attack, such as masonry building foundations. If all the galleries connecting timber in the framework of a building, for example, are broken and cannot be restored, the termites cut off from the nest will usually die without causing much additional damage. The loss of these individuals is unlikely to affect the functioning of the remainder of the colony which will continue to be a possible source of fresh infestation. The position is no different with termite-infested firewood etc., which is moved from one place to another. The termites which survive are unlikely to have the ability of re-establishing themselves as a functioning colony after such a move.

Because termites are so destructive, effective control measures should be implemented as soon as attack has been recognized. The first aim of the control measures adopted should be the destruction of the colony from which the attack originates. Supplementary control measures include the use of barriers which prevent termites from reaching susceptible timbers from their nests in the soil.





Left (Fig. 1).—Mud-covered shelter-tube built over timber stump, bearer, and joist to flooring. Note use of saw-cut in joist and "plastering" between joist and floor. Right (Fig. 2).— Termite-damaged bearer showing thin surface skin of undamaged wood concealing the network of galleries riddling the interior of the piece.

RECOGNITION OF TERMITE ATTACK

Foraging Galleries

Termites normally forage within a radius of 50–60 yards of their nest, but sometimes travel further in search of food. Normally, their foraging galleries are between 4 and 8 in. beneath the surface of the soil but may go deeper if moisture or other surface conditions are unfavourable.

In order to reach susceptible timber, termites may build mud-covered shelter-tubes over materials which they do not attack. A typical shelter-tube is shown in Figure 1, which also illustrates how termites make use of cracks and joints in the surface of the wood.

Attacked Timber

It is quite simple to distinguish the attack of termites from the attack of other wood-boring insects. Termites excavate galleries which follow the grain of the wood, often for several feet, without any surface openings, but which may be protected by only a paper-thin skin of uneaten wood. If this surface skin is broken, as in Figure 2, the exposed galleries may vary in size from small round tunnels about $\frac{1}{8}$ in. in diameter to broad flat channels 2 in. or more in width and up to $\frac{1}{2}$ in. high. In some cases these galleries tend to follow the growth rings of the timber, giving heavily attacked wood a "leaved" or layered appearance when cut; in others, the whole of the interior may be eaten out, leaving only, perhaps, the paint film on the surface. Termite galleries are never packed with "frass" or droppings but may be filled with an irregularly honeycombed structure through which the termites can pass readily.

Termite-damaged timber may be detected by the presence of mud "plastering" along joints and cracks in the surface (see Fig. 1), or by depressed and/or corrugated surface skin which remains after the interior has been eaten. When lightly tapped, damaged wood often has a "papery" sound. Heavier timbers may have to be drilled or probed to determine their soundness.

An active termite infestation may be recognized by the numerous, creamy coloured ant-like insects streaming along the galleries. When an occupied gallery is opened, the termites, which habitually avoid bright lights and exposure to the air, quickly seek shelter away from the opening. If infested timber is extensively disturbed, any termites which survive will attempt to escape and return to undamaged portions of their gallery system.

PRINCIPLES OF ERADICATION

The most satisfactory treatments for the eradication of termite attack from buildings are based on the use of:

- *Poison dusts* which are used to destroy the colony and which depend, for their effectiveness, upon the continued use of the treated galleries by the termites.
- *Treated soil barriers* which may be used to protect a building from termite attack originating in the soil.

Poison dust treatments should be used in preference to other forms of treatment in all cases of *active attack*. After the colony has been destroyed by dust treatments, treated soil barriers may be used to prevent fresh infestation by any new colonies which may invade the area.

Cessation of attack immediately after dusting or other treatment does not necessarily mean that all the termites have been killed—it may mean that they have been disturbed to such an extent that they have merely abandoned the treated galleries. Consequently, once attack has been detected and treated, provision should be made for *regular inspections*, especially beneath suspended wooden floors, to ensure that all fresh attack is treated soon after it occurs. These inspections should be made four or five times a year for several years after the infestation appears to have ended.

Complete eradication of termite attack is seldom easy and may not be achieved until treatments have been repeated several times.

(*To be concluded in next issue.*)

Tannin-Formaldehyde Adhesives

By K. F. PLOMLEY, J. W. GOTTSTEIN, and W. E. HILLIS

MANY PLANTS produce tannins, but properties and yield vary and, as a result, only a few are used commercially. Amongst the most important raw materials for production of tannin extracts are the heartwood of quebracho (*Schinopsis lorentzii*), the bark of the black wattle (*Acacia mollissima*), the bark of the mangroves (*Rhizophora* and *Bruguiera* spp.), the heartwood and bark of the wandoos (*Eucalyptus wandoo* and *E. accedens*), and the bark of the brown mallet (*Eucalyptus astringens*).

In recent years the tannins have attracted interest as a source of phenolic substances which may be reacted with formaldehyde to form a resin. Some of them have potential uses as waterproof adhesives. Their main point of interest is that they are highly reactive and, at present in Australia, cost only about one-third as much as phenol, which is the most important raw material for waterproof plywood adhesives.

A factory for extracting mangrove tannin was recently established in New Guinea. Because of the possibility of supplies of this material being available for new uses, the Division of Industrial Chemistry and, more recently, the Division of Forest Products have carried out an investigation of its suitability as an adhesive base for plywood manufacture.

Early in the investigation adhesives were prepared, using simple formulations, which in shear strength tests complied with the waterproof requirements of the Australian Standard for synthetic resin adhesives for plywood. Values for wood failure, however, were uniformly low and did not comply with the Standard for waterproof plywood.

Later work has shown that, by adding a small proportion of a suitably formulated resin, waterproof adhesives may be prepared which give high values for shear strength and wood failure and withstand immersion in boiling water for 72 hr, giving conformity

Mangrove Tannin Adhesives

Amount of Fortifying Resin (%) (dry solids basis)	Fortifying Resin			
	Phenol Formaldehyde		Resorcinol Formaldehyde	
	Tested Dry	Tested Wet After 6-hr Boil	Tested Dry	Tested Wet After 6-hr Boil
0	309*– 11†	120– 0	221– 0	123– 0
10	278 – 24	200– 35	256– 0	203– 6
20	314 – 50	203– 56	330–76	283–85
30	340 –100	305–100	356–99	312–95

* Glue shear strength (lb/sq. in.). † Wood failure (per cent.).

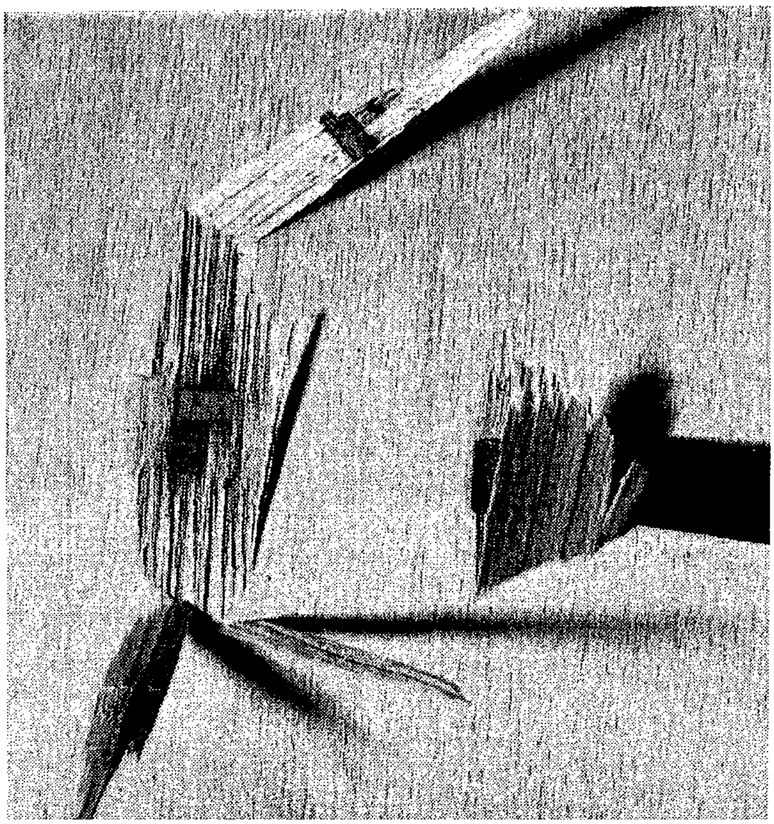
to the latest British weather and boilproof requirements. Laboratory weathering tests of plywood panels bonded with these adhesives are in progress. The amount of fortifying resin necessary depends on a number of factors, including the quality of the tannin, the kind of fortifying resin, and the type of wood being bonded. For soft species the amount of fortifying resin may be as low as 10 per cent. (on a dry solids basis), but for denser woods larger amounts are usually necessary.

Commercially and laboratory made fortifying resins were tested and it was found that suitable formulations of phenol formaldehyde, resorcinol formaldehyde, or resorcinol and phenol formaldehyde with slightly acid to slightly alkaline reaction gave satisfactory results. Under controlled conditions the effect of the fortifying resin appears additive and it should be quite practical to control adhesive strength so as to achieve adequate bonds in a particular species. On the other hand, it should be possible to produce an all-purpose adhesive at moderate cost by addition of an appropriate fortifying resin.

Essentially the method of preparing the adhesive for use is to mix the fortifying resin with a solution of tannin to give a final mix that is moderately acid in reaction (but not sufficiently acid to damage the wood fibre) and contains about 40–50 per cent. of solids. A source of formaldehyde, such as paraformaldehyde, is added and also a small amount of filler. The adhesive is set in a hot press.

Some typical laboratory results with mangrove tannin using klinki pine veneer are shown in the table above.

A test of a phenol formaldehyde–mangrove tannin adhesive (30–35 per cent. phenol formaldehyde) was carried out under commercial conditions using klinki pine veneer. The results were generally very satisfactory,



Knife test of dry panel, showing wood failure.

Wattle and Wandoo Tannin Adhesives

Tannin Base	Amount of Fortifying Resin (%)	Klinki Pine		Coachwood	
		Tested Dry	Tested Wet After 72-hr Boil	Tested Dry	Tested Wet After 72-hr Boil
Wattle	0	290*– 47†	236–100	517– 50	240–100
	10	390 – 97	290–100	570– 81	270– 80
	20	481 –100	296–100	517–100	293–100
	30	423 –100	300–100	600– 93	440–100
Wandoo	0	165– 5	0– 0	287– 0	0– 0
	10	301– 52	150– 21	380– 17	0– 0
	20	369– 96	248– 83	705– 79	253– 20
	30	382– 82	266– 93	732– 90	357– 60

* Glue shear strength (lb/sq. in.). † Wood failure (per cent.).

although the test pointed to the need for shortening the setting time of the fortifying resin and for further study of the variability of the tannin extract and the behaviour of the filler used. Mean glue shear strength and wood failure of seven panels were 360 lb/sq. in. and 95 per cent. tested dry, and 224 lb/sq. in. and 94 per cent. tested wet after boiling for 72 hr. The wood failure obtained on a knife test of the dry panel is shown in the photograph.

Tannin-formaldehyde is fast-setting at temperatures normally used for bonding with phenolic adhesives and this characteristic may be used to reduce the setting time of blends fortified with a slower-setting resin. This can be done by carrying out a partial cure in the press and then completing the cure out of the press at a lower temperature. For example, the setting time of a mangrove tannin adhesive fortified with a phenol formaldehyde resin having a minimum pressing time of 12 min at 140°C (with two $\frac{3}{16}$-in. panels to each press opening) was reduced to 10 min by pressing for that period and then holding at 80°C for 6 hr. Similarly, the pressing time of an adhesive fortified with resorcinol formaldehyde was reduced from 6 min to 4 min at 140°C.

Recently some attention has been given to the adhesive properties of wattle (mimosa) and wandoo (myrtan) tannins. An exhaustive study of these tannins has not yet been made, but the results obtained with adhesives prepared as described above have been very promising. The results of glue shear tests obtained with a resorcinol-phenol-formaldehyde fortifying resin using klinki pine and coachwood veneers are shown in the table above.

Investigations to date have been mainly directed towards production of hot-setting plywood adhesives, but associated tests indicate that hot- or possibly cold-setting tannin-based adhesives may be suitable for bonding other wood products including solid timber, laminates, and wood-particle boards.

The probable cost of tannin-based glue lines is difficult to estimate at this stage of development, because quantity and type of fortifying resin may vary with application and would have a considerable effect on glue line cost. In addition, the market price of tannins is subject to variation. It seems likely, however, that the cost of a general purpose waterproof glue line would be reduced considerably, while for many species costs would be within the range of H.M.R. urea bonds. Under these conditions a single adhesive could be used for H.M.R. and waterproof grades.

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Eradicating Termites (White Ants) from Buildings—Part II

By J. BEESLEY, Wood Preservation Section

POISON DUST TREATMENTS

Poison dust treatments are amongst the simplest of all methods for the control of termite attack and, if properly applied, have an excellent chance of causing the complete destruction of the colony. For best results *all active attack* within the building and in timber within a radius of 50 yards of the building should be treated with the poison dust. Whilst searching for infested timber to treat, special attention should be given to stumps, posts, trees, etc. in which the nest might be hidden.

All termite attack should be treated as soon after its discovery as possible but, if treating materials are not available at the time of discovery, the termites should be left undisturbed until the poisons have been obtained. Poison dust treatments should only be made into galleries in which termites are known to be active. If active attack cannot be found, dusting should be delayed or other treatments substituted.

Why "Dusting" Works

If a very finely divided poison dust is blown into galleries through which large numbers of termites pass, it will adhere to the bodies of passing insects and become widely distributed, and will ultimately be carried back to the nest. If the dust is blown into unoccupied galleries, or galleries which are abandoned soon after treatment, results will be less satisfactory. Hence, dusting must be done with the least possible disturbance to the termites, so that they continue to use the treated galleries.

Good distribution of the poison dust through the gallery system is most important as it will cause deaths wherever termites which have come in contact with the poison are groomed. Initially, deaths will occur because termites keep clean by grooming one another and swallowing the body secretions and particles of poison licked off. Subsequently, other termites will become poisoned when the dead termites are eaten—a normal procedure in the interests of nest hygiene. Thus, each particle of arsenic will be responsible for the deaths of several termites, and a small quantity of poison will completely wipe out a large and thriving colony.

One advantage of poison dust treatments is that complete destruction of the termite colony is possible without actually finding the nest. Treatment of the nest does, however, give more rapid and more reliable results and should always be attempted.

How to Dust

Finely divided dry white arsenic (arsenic trioxide) has proved to be one of the best poisons for dust treatments as it blows freely and does not lose its toxicity. It should be blown into as many different occupied galleries as can be found, so as to obtain maximum distribution of the poison.

Only a very small amount of arsenic should be used, ¼ oz being enough to treat 18–24 galleries. Alternatively, three or four vigorous puffs from a hand-blower into each gallery is sufficient. If arsenic trioxide is not readily available Paris green can be used as a substitute. In either case the dust should be blown in as a fine "smoke" and great care taken not to use excess, as otherwise termites are likely to seal off the treated galleries and thus defeat the purpose of the treatment.

Where to Dust

Dusting should be applied wherever active termite attack can be found inside the house, under the house, or within a radius of 50 yards or so of the house.

- *Inside the House.*—Make a careful search for infested timber, giving special attention to flooring, skirtings, and architraves. Carefully raise a splinter from the surface of damaged wood and, if termites can be seen moving in the exposed galleries, blow in three or four vigorous puffs of arsenic. Replace the splinter and seal it down with adhesive tape. Long boards should be treated every 4 or 5 feet.

- *Under the House.*—Make a careful search for ALL the galleries or mud-covered runways leading from the soil into the building (see Fig. 1). These may be built over piers and stumps, or may be concealed in the corners of brick foundations or in checks or cracks in timber stumps. A small hole (⅛ in. in diameter) should be pricked into each runway, preferably near the point at which it emerges from the soil, taking extreme care not to break the structure, which is very fragile. Into this blow three or four puffs of arsenic dust. Then seal the treating hole with wet clay, again taking care not to crush the gallery.

Whilst looking for galleries under the house, a search should also be made for the nest. It may be quite an obvious mound or it may be concealed in the earth fill under a concrete slab floor or hearth. All likely places should therefore be examined carefully and probed to determine their soundness. No matter what the external shape or covering of the nest, its inner zones, centred around the nursery, always consist of concentric layers of cells with thin, fragile walls of compacted clay and organic matter (see Fig. 3).

- *Within 50 Yards.*—Carefully examine all trees, logs, stumps, poles, posts, or other timber within a radius of 50 yards or so of the infested building for signs of termite attack. Any suspected of harbouring termites should be drilled (½ in. auger hole is ample) and, if found to be infested, treated with arsenic dust as already described. Plug all treating holes with a dowel or moist clay.

During this search give special attention to trees or wood from which "flying ants" have been seen to swarm. The alates of most termite species are released from within a few feet of the nest, and their presence is a very useful guide to its location.

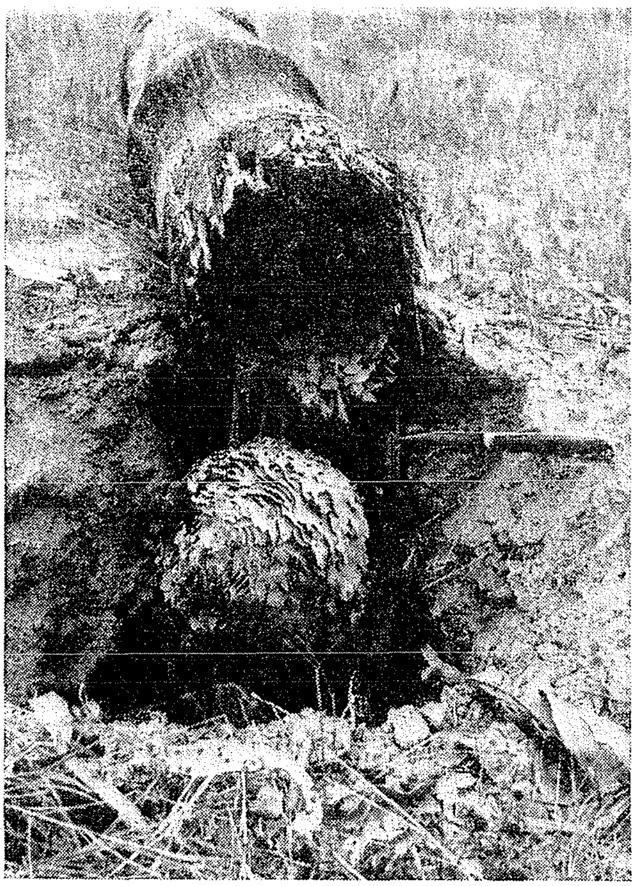

Fig. 3.—Termite nest discovered in the butt of a condemned pole. Note the layers of thin-walled cells of which it is composed.

Destroying the Nest

Destruction of the whole termite colony is the ultimate aim of poison dust treatments. When found, the nest may be dug out and broken up or else destroyed by arsenic poisoning.

If the nest is in the form of a mound, or is in a stump or log, its destruction is not difficult. If it is not readily accessible (e.g. in a living tree or under a concrete floor) it may be poisoned by using about $\frac{1}{4}$–$\frac{1}{2}$ oz of arsenic dust blown into several holes drilled into the centre of the nest, or else by flooding the nest with one of the chemicals used for soil poisoning.

Arsenic dust or emulsions of dieldrin or chlordane do not usually affect the health of a vigorously growing tree when used to poison a termite colony in its heart.

Retreatments

All galleries and runways treated with arsenic dust should be left undisturbed for 2–3 weeks to give the poison time to act. At the end of that period, treated galleries should be carefully re-opened, and any found to be occupied by active termites should be re-treated. Repairs and replacements should not be made until all activity has ceased.

Whilst making repairs, all possible precautions against re-infestation should be taken. Such precautions include the improvement of sub-floor ventilation wherever it is deficient, and the formation of treated soil barriers around unprotected foundations.

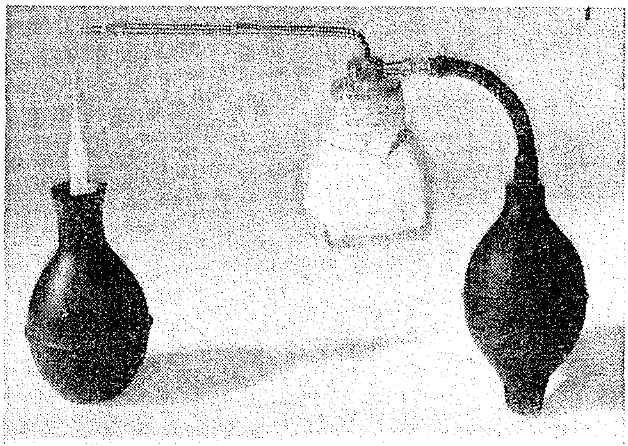

Fig. 4.—Two types of poison dust distributors. The "puffer" on the left costs only 4s. 6d., the one on the right more than £2 10s.

Dusting Equipment

Almost any type of hand-operated dust distributor with a small orifice capable of blowing a "smoke" of arsenic dust into termite galleries is suitable. Two types are illustrated in Figure 4.

While using arsenic or other poison dusts great care should be taken to avoid inhaling or swallowing even the smallest quantities.

(*The final part, on treated soil barriers, will be published next month.*)

Let's Discuss Sawing

with D. S. JONES, Utilization Section

Hook Angle for Circular Ripsaws

It has been amply demonstrated that hook angle has a profound influence on the efficiency of circular saws. Experimental evidence is available from several laboratories. For example, at the Forest Products Laboratory, Madison, Wisconsin, the power required to run a circular ripsaw decreased about 10 per cent. when the hook angle was increased from 15° to 28°, but then increased again to its original value when the hook angle was further increased from 28° to 41°. Workers at the Norwegian Institute of Wood Technology in Oslo found that there was a definite decrease in the power consumed by the saw when the hook angle was increased from –10° to 30°, but a further increase to 40° effected little change. Other laboratories have demonstrated that when the hook angle on circular ripsaws was increased from 15° to 30° there was a power saving of approximately 12 per cent., thus agreeing with the results obtained at Madison. Larger hook angles also have the advantage of reducing the saw's resistance to feeding. Indeed, it is sometimes possible with large positive angles to have a saw draw the timber into the cut without any external feeding force being applied.

The experimental results given above indicate that, while a marked improvement is obtained by increasing hook angle up to 30°, little, if any, advantage is gained from angles greater than 30°. In fact it is not uncommon for sawing efficiency to fall off when larger angles are used. This is probably because the teeth have been weakened by the larger angles to such an extent that they are easily deflected sideways and cut a wider irregular kerf, and vibrations are set up which impair their cutting efficiency. Also the marked reduction in feeding force indicates that the saw may now be loaded with too much of the work that the feed mechanism should be doing. In addition, the increased fibre tearing action of the larger hook coupled with the roughness resulting from tooth deflections gives a very much rougher sawn surface.

It is customary to employ smaller hook angles for the harder-cutting species than the softer, but it should be remembered that even with the harder species, if other circumstances allow hooks up to 30° to be used, easier cutting and feeding will result.

A point to be watched when gulleting saws, especially when an automatic grinder is used, is that, even though the machine may have originally been set up to grind 30° hook, the angle produced will often decrease as the stone wears. Hence frequent dressing of the stone is necessary to maintain the correct hook angle.

The reduction in power consumption and feeding force accompanying an increase in hook angle up to 30° allows the same saw to make deeper cuts and to be fed faster. Alternatively, if these remain the same, lighter gauge saws can be used. For example, a saw doctor in a well-known sawmill had trouble with a 44-in. 9-gauge saw in a No. 1 breast bench. He soon discovered that due to stone wear the hook angle on the saw was only about 20°. On increasing the angle to 30° not only was the trouble with the 9-gauge saw eliminated, but it was found that a 10-gauge saw successfully did the job that was previously too heavy for the 9-gauge.

British Commonwealth Forestry Conference

THIS YEAR Australia has been host country (together with New Zealand) to the Seventh of the five-yearly British Commonwealth Forestry Conferences.

This has been of particular interest to the Division, as prior to the main Conference, a Forest Products Research Conference was held at the Division from August 12 to 16.

Delegates to this Conference were :

Dr. F. Y. Henderson, Director, Forest Products Research Laboratory, Princes Risborough. England.

Mr. J. H. Jenkins, Chief, Forest Products Laboratories of Canada.

Professor R. W. Wellwood, University of British Columbia, Vancouver. Canada.

Mr. J. H. van Wyk, Chief Research Officer, Forest Research Institute, Pretoria. South Africa.

Mr. J. S. Reid, Engineer in Forest Products, New Zealand Forest Service.

Mr. H. R. Orman, Senior Forest Products Research Officer, New Zealand Forest Service.

Mr. E. B. Huddleston, Chief, Division of Wood Technology, N.S.W. Forestry Commission.

Mr. S. G. Jennings, Officer-in-Charge, Forest Products Research Branch, Department of Forestry, Queensland.

Mr. J. J. Byrne, Chief, Division of Forest Products Research, United States Forest Service, Washington. U.S.A. (Guest delegate.)

Mr. S. A. Clarke (Chief) and Dr. H. E. Dadswell (Assistant Chief) represented the Division of Forest Products.

Mr. S. A. Clarke was elected Chairman and Mr. J. S. Reid Vice-chairman.

Important policy matters affecting co-operation between the various laboratories were discussed, and a summary of the work of each laboratory was presented by its representative. Overseas delegates paid tribute to the high standard of the fundamental research of the Division.

During the week following the Conference, delegates visited Tasmania, where they inspected two pulp and paper mills, sawmills, and a plywood factory.

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The Formation of Lignin in Plants

Wood consists of about 70–80 per cent. by weight of cellulose and related carbohydrates, and 20–30 per cent. of lignin. The lignin is located mainly between the fibres, cementing them together like mortar between bricks. Some of the lignin is, however, in the walls of the individual fibres. This can be seen in the ultraviolet photomicrograph, Figure 1, in which a cross section of a number of fibres of *Eucalyptus regnans* is enlarged 2000 times, and in which the black regions correspond to where most lignin is present.

Since lignin acts as a cementing material between the fibres, obviously this will be an important factor determining the strength properties of wood, and also in the separation of fibres in the manufacture of pulp. Chemically the nature of lignin is still unknown in detail, but its general structure has been determined by organic chemists. It is known that it is built up by the condensation of simpler substances which are phenolic in nature.

Because of its extremely complex chemical nature, which makes the determination of its exact structure very difficult, scientists have over the past decade turned to other than the purely chemical approach in their study of it. A conference to review progress along these newer lines of research was held at the Institute of Paper Chemistry, in Appleton, Wisconsin, in September 1956, and was attended by a member of this laboratory. More recent research has been directed along two main lines. Attempts have been made, firstly, to convert simple substances thought to be involved in lignin formation (precursors) into lignin-like substances under controlled laboratory conditions, and secondly, to study the factors governing the formation of lignin in wood itself. These approaches differ from previous work in that they are not directed to the determination of the exact chemical nature of lignin. Instead, it is now proposed, through increasing our understanding of factors governing lignin formation, to find ways of enhancing its formation in wood which would alter the properties of the wood; or, alternatively, to find ways of facilitating its removal and so improve at least our understanding, if not the practice, of pulp production.

In test tube experiments it has been found possible to convert relatively simple substances such as eugenol (the main constituent of clove oil) into substances remarkably similar to lignin. This change takes place in the presence of an enzyme called peroxidase, which facilitates the reaction, and hydrogen peroxide. Furthermore, the amount of lignin-like material which forms depends on the presence of a suitable matrix on which the material deposits, and this is important in deciding factors influencing the location of lignin in fibres.

In living trees it has been demonstrated that similar chemical systems exist and it may

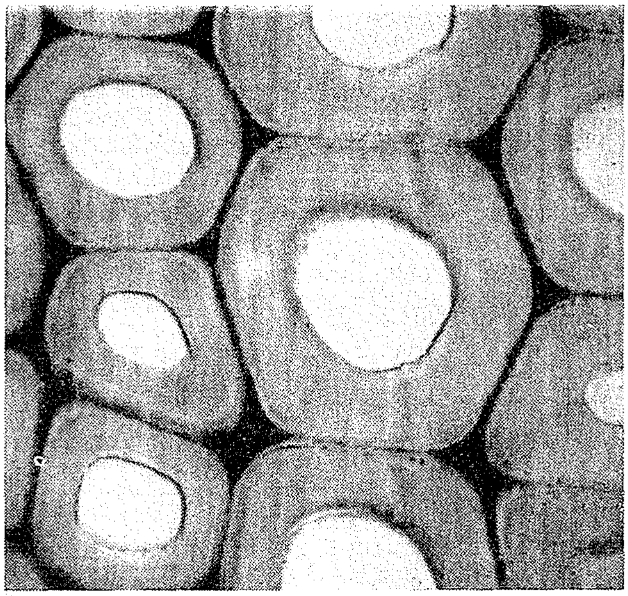

Fig. 1.—Cross section of eucalypt fibres, enlarged approx. 2000 times.

be assumed that lignin formation proceeds in general along the lines the test tube experiments suggest. It has also been possible to detect in the sap of growing trees substances which, as the work of organic chemists suggests, are possible precursors of lignin. These substances may be made synthetically and when fed to isolated parts of plants in nutrient media (tissue culture) the deposition of lignin is enhanced. These substances may also be made radioactive and when injected into living trees in the growing zone between the wood and the bark (the cambium), the movement of the radioactive precursors may be traced by various techniques. They can be shown to move inwards from the cambium and by their radioactivity can be shown to be incorporated in the lignin deposited.

This has given rise to one hypothesis that the lignin precursors develop in the cambium and then migrate inwards, where a series of reactions, similar to the test tube experiments, results in the formation of lignin. The formation of lignin is also known to be related to the presence of various hormones in the trees as well as to environmental factors such as light, and to water supply.

Physical techniques, such as electron microscopy, X-ray diffraction, and ultraviolet microscopy, as well as chemical methods have increased our knowledge of the distribution of lignin in the fibre walls, and of its physical relation to cellulose and carbohydrates.

At the Appleton Conference many of these aspects of lignin formation were discussed and from the results of work presented it was clear that much of the mystery which has surrounded the nature and formation of lignin for nearly a century may soon be resolved.

PROPERTIES OF AUSTRALIAN TIMBERS

Myrtle Beech

MYRTLE BEECH is the standard common name of the timber designated botanically *Nothofagus cunninghamii*. It is also known as Tasmanian myrtle, Tasmanian beech, myrtle, and beech. The species belongs to the same family as the true beech (*Fagus* spp.).

Habit and Distribution

Myrtle beech under favourable conditions attains a diameter of 3–5 ft and reaches over 100 ft in height. Giants of the species were occasionally found up to 40 ft in girth and 200 ft in height. The limbs tend to grow well down the trunk, which is often faulty. Thus timber recovery is generally low. The tree grows in cool, damp, sheltered gullies in north and west Tasmania and south-east Victoria.

Timber

The timber has a pale, whitish sapwood and a pink to reddish-brown heartwood, often separated by a pale intermediate zone which behaves like sapwood. The grain is straight or slightly interlocked and occasionally wavy. Its texture is fine and even. It is fairly hard, strong, tough, and stiff although moderately light in weight, averaging 45 lb/cu. ft air dry. The sapwood often has a high starch content, but because of the small pore size *Lyctus* attack is not common. The timber is not at all durable and cannot be recommended for exterior use. Myrtle beech works easily with hand or machine tools, turning and shaping particularly well. It peels and slices well, glues easily, can be fumed and bent successfully and takes a high polish.

Seasoning

The seasoning of myrtle beech presents some problems owing to large variations in moisture content between trees and even within trees. All sizes of boards should be partially air-dried to about 30 per cent. moisture content and then separated into "red" and "white" material before kiln-drying. The lighter "white" myrtle beech presents no difficulties but the "red" variety should be slowly and carefully dried. Internal checking and the cupping of backsawn boards are the most common types of degrade encountered, but collapse is frequently sufficient to warrant reconditioning treatment.

Uses

Used mostly for cabinet work and furniture, myrtle beech is also in great demand for turning and carving, especially in the shoe. textile, and brush trades. It is also used for motor bodies; bridges, wrest planks, and hammers in pianos; and high class floors and panelling. It also makes a highly satisfactory plywood.

Availability

The timber is available in boards of medium lengths and widths, and in turnery squares. Veneer and plywood can also be obtained.

Eradicating Termites (White Ants) from Buildings—Part III

By J. BEESLEY, Wood Preservation Section

TREATED SOIL BARRIERS

In new houses a properly formed barrier of treated soil can be expected to give good protection against termite attack for more than 10 years. Soil barriers also provide a useful method of preventing termite attack in completed houses which have not been given any other form of protection and, sometimes, may be used to control attack in buildings which are difficult to treat by other means.

The formation of treated soil barriers is seldom difficult while a building is still under construction. In completed brick-veneer and timber houses their installation is laborious but not otherwise difficult if there is good access beneath the floor. Brick houses, after they have been occupied, can seldom be satisfactorily protected by treated soil barriers because access beneath the floor is usually poor, wall cavities extending below ground level are difficult to treat, and the earth fill beneath concrete slab floors and hearths is usually inaccessible.

Treated soil barriers cannot be relied upon to give protection against termite attack unless they *completely surround* all foundations, stumps, etc. over which the termites would have to pass in order to reach the superstructure of the building. The stumps under timber houses are easily protected, provided each is accessible. In addition to surrounding each stump in a brick-veneer house, the barrier should extend around the *inside* edge of the external brick wall. In brick houses, it is necessary to form a barrier around all internal walls as well as around the inside edge of the external walls. A barrier is seldom required around the outside edge of external walls, because these can be inspected and treated with poison dusts if there is any evidence of termite activity.

Forming the Barrier

A treated soil barrier consists of a V-shaped trench about 6 in. wide and equally deep. filled with soil which has been saturated with preservative. The treated soil should be in direct contact with the foundation it protects. Timber stumps may be given additional protection by "jetting" the end, on which the bearers rest, with preservative as a precaution against termites tunnelling up through the centre of the stump.

All barriers should be inspected periodically to ensure that they have not been bridged by untreated soil, building off-cuts. or materials stored under the house, such as timber or firewood.

Chemicals and Concentrations

Only chemicals which can be relied upon to give satisfactory protection against termite attack for 10 or more years are acceptable for soil treatments. The choice is therefore limited and is usually restricted to chemicals which are not too unpleasant to handle.

Soil treating chemicals are normally packed as liquid concentrates which may be diluted with water to form emulsions or with light mineral oils (diesel distillate and diesel fuel oil) to form true solutions. As a rule the oil solutions are more permanent than water emulsions of the same chemicals, but are more costly to use and are a definite fire hazard for the first few weeks after installation. Sodium arsenite is the only chemical, of the four listed in the following table, which does not mix with mineral oils.

Chemicals for Soil Treatments

Measure all quantities accurately

Chemical	Concentration when Packed (%)	Concentration when Used (lb in 10 gal.)	Gallons from 1 gal. of Concentrate
Sodium arsenite	80–90	10	9–10
Chlordane	80	2	40
Dieldrin	16–24	0·5	32–48
B.H.C.*	various	1·0	as stated

* Refers only to the pure gamma-isomer of benzene hexachloride.

Sodium arsenite should be used only under houses which have a continuous external foundation wall and where there is no possibility of it contaminating water supplies. Contact with sodium arsenite will damage or kill garden plants.

The other chemicals listed are relatively harmless to garden plants if used as emulsions but are likely to cause damage when mixed with light oils.

Quantity Required

The quantities of chemical solution normally required for soil treatments are:

1 gallon per cubic foot of soil, or
1 pint per lineal foot of V-trench, or
2 pints per house stump.

These quantities may have to be increased slightly for absorbent soils, and an allowance of at least 10 per cent. should be made for wastage.

Availability

The chemicals listed are usually stocked by hardware stores, stock and station agents, pest eradicators, and suppliers of agricultural chemicals. All reputable brands are clearly labelled with the concentration of active constituents, which should always be checked before the purchase is made, and again before mixing.

Warning

All the chemicals mentioned in this article should be regarded as *poisons* and handled with caution. Avoid using them where they might contaminate water supplies or come in contact with cooking utensils, food, etc. In the event of accidental spillage on the body or clothes prompt washing with soap and water is usually sufficient. Take special care in disposing of empty containers and surplus solution after using arsenicals.

Regularly inspect all treated soil barriers!

DONATIONS

Owing to lack of space, the following donations, which have been received over the last three months, have not been published until this issue:

Orient Steamship Co., Melbourne	£10 10 0
B. A. Farquar, Scottsdale, Tas.	£15 0 0
Wiltshire File Co., Melbourne	£26 5 0
Kiln Dried Timbers, Cooroy, Qld.	£150 0 0
Furness Ltd., Edwardstown, S.A.	£100 0 0

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Circular Ripsaws— What Clearance Angle?

By R. L. COWLING, Utilization Section

SAW FILERS and investigators the world over do not agree about the amount of clearance necessary behind the cutting edges of saw teeth. An angle of $7\frac{1}{2}°$ has been stated to be sufficient, but greater angles are usual, and approximately 20° is common for Australia, as shown in Figure 1. By calculation, 1 to 2° clearance is sufficient, but in practice more is necessary because of the fibrous nature of wood.

What angle of clearance is sufficient? And what most affects the clearance angle? Is it the form of tooth, the speed of feed, the type of timber, or the depth of cut? A simple test within the Division, while not providing a complete answer to all of these questions, has yielded some interesting results.

The method of test was simply to prepare the teeth of a 42 in. diameter circular saw so that the angles of clearance varied, and to paint the teeth with a quick-drying lacquer to observe the points of wear when the saw was operated. Initially, the clearance angles tested ranged from 0 to 21°, but for subsequent tests the smaller clearances were eliminated. The width of lacquer wear behind the cutting edges was measured as a method of assessing the clearance desirable.

The test conditions closely resembled those normally pertaining to Australian No. 1 sawbenches, except that only two depths were sawn, viz. 12 in. and 3 in., and feeds faster than 84 ft/min were obtained manually.

The timbers were sawn in the green state and comprised messmate stringybark (*Eucalyptus obliqua*), Queensland grey ironbark (*E. paniculata*), and radiata pine (*Pinus radiata*), which have air-dry densities at a moisture content of 12 per cent. averaging 44, 68, and 35 lb/cu.ft. respectively. Thus a wide range of density was represented, and also two types of timbers, since one was a softwood. The maximum feed speeds in the three species were 350, 315, and 400 ft/min respectively in the 3 in. depth of cut. Sawing

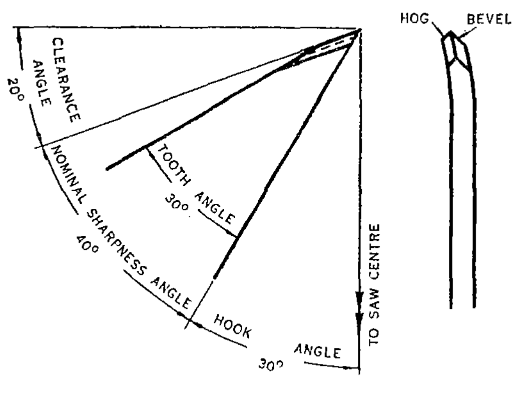


Fig. 1.—Form of tooth common in Australian sawmills.

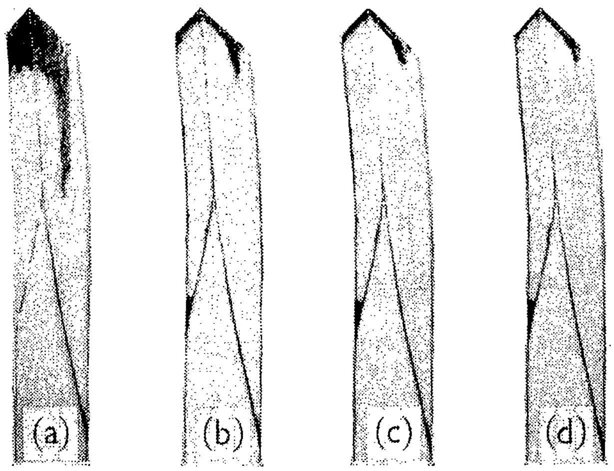


Fig. 2.—*Tooth top wear decreasing with increasing clearance—feed speed* 42 *ft/min. Clearance angles* (a) 3°, (b) 6°, (c) 9°, (d) 12°.

in the 12 in. depth was restricted to messmate stringybark and to a maximum feed speed of 84 ft/min.

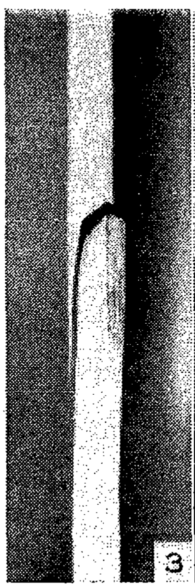
It is perhaps surprising that the softwood (radiata pine) appeared to require no greater clearance than the other timbers, even though it has a longer fibre and was fed a little faster. Grey ironbark, although much more difficult to saw than messmate stringybark, likewise appeared to require much the same clearance.

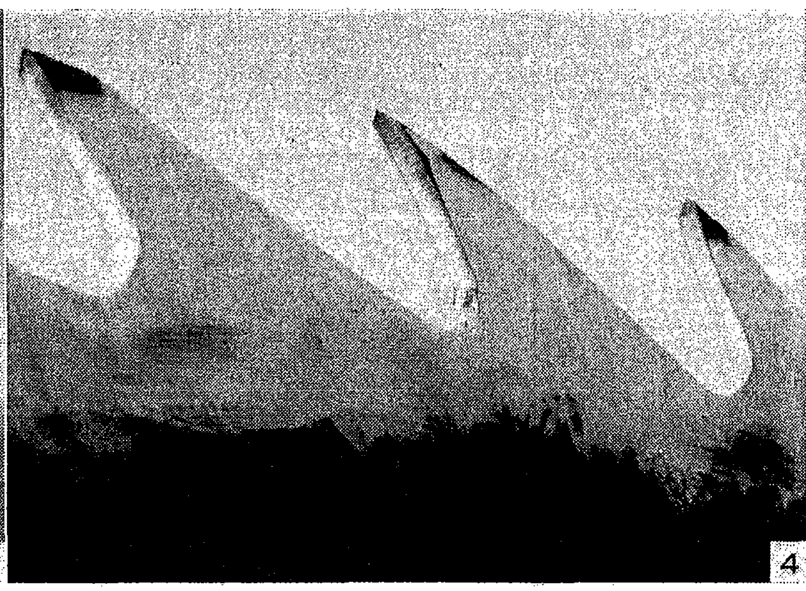
The change in depth of cut appeared to have no influence on the clearance required.

The effect of increasing the feed speed was more noticeable for feeds between 42 and 160 ft/min than for faster feeds, and was far more noticeable on teeth with 3° clearance than for greater clearance angles. The marked decrease in wear of lacquer between clearance angles of 3° and 6° is shown in (*a*) and (*b*) of Figure 2, the feed speed being constant in this instance. The decrease in wear from 6° to 12°, (*b*) to (*d*), is much less. When the feed speed was increased to the maximum, all the lacquer on the top of teeth with 3° clearance was worn off, with relatively slight increase in wear for other clearance angles.

The large backward streak in (*a*), and the lesser bulges in the wear in (*b*), (*c*), and (*d*), occur as a result of the bevel on the teeth. The position of these bulges marks the limit of engagement of the cutting edge, and does not mark the "tooth bite" (depth of penetration of the tooth into the wood) as may be supposed. The bulge cannot occur if there is no bevel, as for a swage-set tooth. It is unlikely to occur for small bevel angles, and will disappear if the speed is sufficiently fast, as shown in Figure 3.

The bulge was present for all clearance angles tested up to feed speeds of 84 ft/min, and would certainly be present for much of the work of the usual No. 1 sawbenches. Its





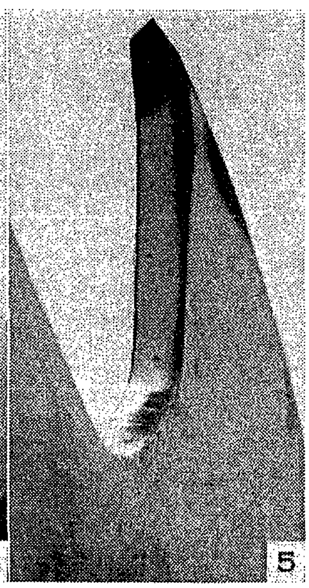


Fig. 3.—*Typical wear for feed speeds exceeding* 160 *ft/min—clearance angle* 15°. *Fig.* 4.—*View showing wear on the side of set (first and third teeth), and annular wear developing below gullets. Feed speed* 84 *ft/min—depth of cut* 12 *in. Fig.* 5.—*Typical wear in front and on side of teeth, in gullet, and faint wear below gullet. Feed speed* 160 *ft/min—depth of cut* 3 *in.*

length decreased with increase in clearance angle up to an angle of 21°, hence it would appear to influence the choice of this angle for No. 1 sawbench work. Further evidence supporting the choice of 21° clearance appears in Figure 4, where friction on the sides of the teeth near the tips is evident. With smaller clearance angles the teeth would become wider at this point and friction would then become of greater importance.

Another source of frictional loss appears to be indicated by the rather faint wear marks below the gullets in Figures 4 and 5. When well developed, this wear takes the form of a complete ring around the saw, approximately ½ in. wide, and outside the range of the saw packing. It appears to be caused by sawdust forcibly expelled into the kerf. Wear marks down the front of each tooth always indicated that the chip moved away from the side of set towards the kerf face on the opposite side, and confirmatory wear, especially in the gullet at the base of the tooth, is clearly seen in Figure 5.

We do not know by how much we can reduce friction and improve saws by careful attention to the design of saw teeth. Future research may show us, but meanwhile there appears little wrong with the shape of saw teeth or with the clearance usually adopted.

A Further Note on Radiata Pine

By H. KLOOT, Timber Mechanics Section

(*The article on radiata pine published in our July issue has attracted a great deal of interest. Here, the author discusses another interesting facet of the characteristics of this timber.*)

IN THE GRADING RULES for some important timbers used overseas—Douglas fir is a good example—special mention is often made of acceptable limits on the rate of growth, i.e. the number of rings per inch, in a piece of structural timber. Such a provision is also frequently incorporated in specifications for timber to be used in ladders. The purpose of a clause limiting growth rate is to eliminate timber of very fast growth rate (less than say 5 or 6 rings per inch) or very slow growth rate (more than say 20 or 30 rings per inch), as investigations have shown that in some timbers this material tends to be weaker and more brittle than wood of normal rate of growth.

The question arises as to whether such a provision could usefully be applied to radiata pine for structural purposes. At first sight, it appears to be a promising means of eliminating the wood close to the pith—which is usually very fast grown and which is not only low in density and strength but also has the unfortunate characteristic of warping on drying.

Careful analysis of data accumulated by the Division on radiata pine from various sources and age classes indicates, however, that this is a false hope. It has been found that there is a very poor relationship between rate of growth and strength, so poor in fact that it is valueless for practical purposes.

Figure 1 shows the compression strengths of a large number of defect-free green samples taken from 40-year-old radiata pine from Mt. Burr, S. Australia, and the

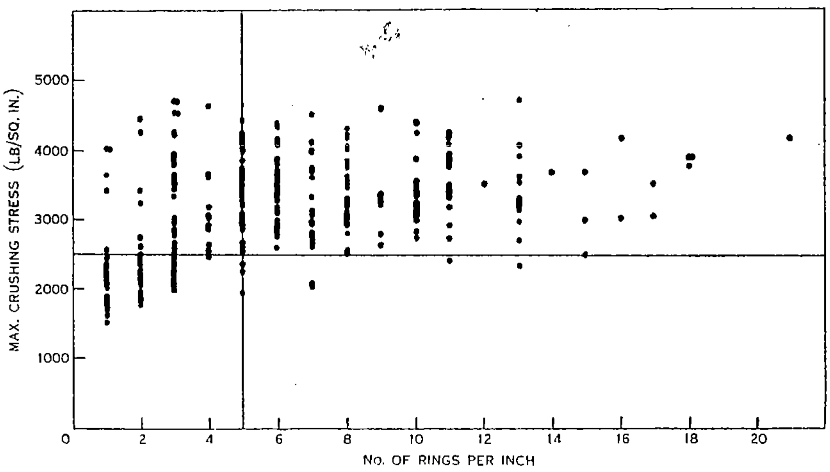


Fig. 1.—Compression strength v. rate of growth of 40-year-old radiata pine from Mt. Burr, S.A.

rate of growth, expressed in rings per inch, in each sample. It is clear at a glance that there is little real relationship between the two variables, and the impracticability of specifying rate of growth to eliminate material of low strength is illustrated in the following example.

To be able to use a reasonable value for working stress in compression, it would be necessary to eliminate all pieces with a compression strength less than 2500 lb/sq.in. Say 5 rings per inch is chosen as the fastest growth rate allowable. First of all, it is seen that some specimens, even one with as many as 13 rings per inch, fall below the limit set of 2500 lb/sq.in. This perhaps is not particularly serious, as the number of weak pieces is small. However, the number of pieces with strengths greater than 2500 lb/sq.in., but which would be rejected for having less than 5 rings per inch, is too large to be tolerated. If the limit is reduced to 3 rings per inch, the proportion with satisfactory strength but too fast a rate of growth obviously decreases, but the number with an acceptable growth rate and insufficient strength substantially increases.

It is therefore clear that no useful purpose would be served by limiting the number of rings per inch in radiata pine for structural purposes.

Foresters reading this will immediately draw the obvious inference that no matter how fast they grow their trees, the strength properties of the wood will not suffer. This may be so and, in fact, is the conclusion reached by Turnbull in his intensive study of pines in South Africa. However, the Division's investigations have not yet progressed sufficiently to allow a categorical answer to be given on this point.

PERSONAL

Dr. A. B. Wardrop, Senior Principal Research Officer in Wood and Fibre Structure Section of the Division of Forest Products has, on the basis of his published work, been awarded the degree of D.Sc. by the University of Melbourne.

Boas Institute of Forest Products

Many people in the Australian timber and pulp and paper industry will remember Mr. I. H. Boas, the first Chief of the Division of Forest Products, C.S.I.R.O. He retired in 1944. As a tribute to the contribution which he made to forest products research, the Israeli Government decided to name their new forest products laboratory "The Boas Institute of Forest Products".

In a recent letter, Dr. A. Y. Goor, Conservator of Forests, Ilanoth, Israel, has written as follows:

" It is our privilege to inform you that on this day, October 16th, the second anniversary of the death of Isaac Herbert Boas, we have commemorated the Boas Institute of Forest Products. This building and equipment has been made possible by funds allocated by the Government of Israel with support by the Society of Israeli Foresters."

"The Boas Institute is located at the Headquarters of the Government Department of Forestry, Ilanoth, and has approximately 2000 square feet of floor space housing facilities for the study of all phases of wood utilization and wood technology, exclusive of wood chemistry. Modest though our facilities may be, we hope the Boas Institute will be a fitting memorial to a pioneer in Australian Forest Products research and to a man who did much to inspire forestry activities in Israel."

DONATIONS

The following donations were received by the Division during October:

Perfectus Air Screw	£10 10 0
Nightingale Chemicals (N.S.W.) Pty. Ltd.	£75 0 0

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